Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for all specified equipment and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Indicate on drawings:

.1 Mounting arrangements.

.2 Operating and maintenance clearances.

.2 Shop drawings and product data accompanied by:

.1 Detailed drawings of bases, supports, and anchor bolts.

.2 Acoustical sound power data, where applicable.

.3 Points of operation on performance curves.

.4 Manufacturer to certify current model production.

.5 Certification of compliance to applicable codes.

1.2 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.

.1 Operation and maintenance manual approved by, and final copies deposited with, Consultant before final inspection.

.2 Operation data to include:

.1 Control schematics for systems including environmental controls.

.2 Description of systems and their controls.

.3 Description of operation of systems at various loads together with reset schedules and seasonal variances.

.4 Operation instruction for systems and component.

.5 Description of actions to be taken in event of equipment failure.

.6 Valves schedule and flow diagram.

.7 Colour coding chart.

.3 Maintenance data to include:

.1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.

.2 Data to include schedules of tasks, frequency, tools required and task time.

.4 Performance data to include:

.1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.

.2 Equipment performance verification test results.

.3 Special performance data as specified.

.4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.5 Approvals:

.1 Submit 2 copies of draft Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless directed Consultant.

.2 Make changes as required and re-submit as directed by Consultant.

.6 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.7 Site records:

.1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.

.2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.

.3 Use different colour waterproof ink for each service.

.4 Make available for reference purposes and inspection.

.8 As-built drawings:

.1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.

.2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).

.3 Submit to Departmental Representative for approval and make corrections as directed.

.4 Perform testing, adjusting and balancing for HVAC using as-built drawings.

.5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

.9 Submit copies of as-built drawings for inclusion in final TAB report.

1.3 MAINTENANCE MATERIAL SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Furnish spare parts as follows:

.1 One set of packing for each pump.

.2 One casing joint gasket for each size pump.

.3 One glass for each gauge glass.

.4 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.

.3 Provide one set of special tools required to service equipment as recommended by manufacturers.

.4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Replace defective or damaged materials with new.

.4 Develop Construction Waste Management Plan.

.5 Packaging Waste Management: remove for reuse and recycling.

Part 2 Products

2.1 MATERIALS

.1 Not applicable.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 PAINTING REPAIRS AND RESTORATION

.1 Do painting in accordance with Section 09 91 23 - Interior Painting.

.2 Prime and touch up marred finished paintwork to match original.

.3 Restore to new condition, finishes which have been damaged.

3.3 SYSTEM CLEANING

.1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

3.4 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.5 DEMONSTRATION

.1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

.2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.

.3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.

.4 Instruction duration time requirements as specified in appropriate sections.

.5 Departmental Representative may record these demonstrations on video tape for future reference.

3.6 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.7 PROTECTION

.1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.

.2 Canadian Standards Association (CSA International)

.1 CSA B139, Installation Code for Oil Burning Equipment.

.3 Green Seal Environmental Standards (GSES)

.1 Standard GS-11, Environmental Standard for Paints and Coatings.

.4 National Fire Code of Canada (NFCC 2005)

.5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards

.1 SCAQMD Rule 1113, Architectural Coatings.

.2 SCAQMD Rule 1168, Adhesive and Sealant Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and recycling

Part 2 Products

2.1 MATERIAL

.1 Refer to other sections for materials specifications for piping.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 CONNECTIONS TO EQUIPMENT

.1 In accordance with manufacturer's instructions unless otherwise indicated.

.2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.

.3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.3 CLEARANCES

.1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and National Fire Code of Canada.

.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer without interrupting operation of other system, equipment, components.

3.4 DRAINS

.1 Install piping with grade in direction of flow except as indicated.

.2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.

.3 Pipe each drain valve discharge separately to above floor drain.

.1 Discharge to be visible.

.4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.5 AIR VENTS

.1 Install automatic air vents at high points in piping systems.

.2 Install isolating valve at each automatic air valve.

.3 Install drain piping to approved location and terminate where discharge is visible.

3.6 DIELECTRIC COUPLINGS

.1 General: compatible with system, to suit pressure rating of system.

.2 Locations: where dissimilar metals are joined.

.3 NPS 2 and under: isolating unions or bronze valves.

.4 Over NPS 2: isolating flanges.

3.7 PIPEWORK INSTALLATION

.1 Screwed fittings jointed with Teflon tape.

.2 Protect openings against entry of foreign material.

.3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.

.4 Assemble piping using fittings manufactured to ANSI standards.

.5 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.

.1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.

.6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.

.7 Install concealed pipework to minimize furring space, maximize headroom, conserve space.

.8 Slope piping, except where indicated, in direction of flow for positive drainage and venting.

.9 Install, except where indicated, to permit separate thermal insulation of each pipe.

.10 Group piping wherever possible.

.11 Ream pipes, remove scale and other foreign material before assembly.

.12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

.13 Provide for thermal expansion as indicated.

.14 Valves:

.1 Install in accessible locations.

.2 Remove interior parts before soldering.

.3 Install with stems above horizontal position unless indicated.

.4 Valves accessible for maintenance without removing adjacent piping.

.5 Install globe valves in bypass around control valves.

.6 Provide valves at branch take-offs for isolating purposes except where specified.

.7 Install butterfly valves between weld neck flanges to ensure full compression of liner.

.8 Install ball valves for glycol service.

.9 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.

.15 Check Valves:

.1 Install silent check valves on discharge of pumps.

.2 Install swing check valves in horizontal lines on discharge of pumps.

3.8 SLEEVES

.1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.

.2 Material: schedule 40 black steel pipe.

.3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.

.4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.

.5 Installation:

.1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.

.2 Other floors: terminate 25 mm above finished floor.

.3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.

.6 Sealing:

.1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.

.2 Elsewhere:

.1 Provide space for firestopping.

.2 Maintain fire rating integrity.

.3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.

.4 Ensure no contact between copper pipe or tube and sleeve.

3.9 ESCUTCHEONS

.1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.

.2 Construction: one piece type with set screws.

.1 Chrome or nickel plated brass or type 302 stainless steel.

.3 Sizes: outside diameter to cover opening or sleeve.

.1 Inside diameter to fit around pipe or outside of insulation if so provided.

3.10 PREPARATION FOR FIRE STOPPING

.1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with Section 07 84 00 - Fire Stopping.

.2 Uninsulated unheated pipes not subject to movement: no special preparation.

.3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging fires topping material or installation.

.4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

3.11 FLUSHING OUT OF PIPING SYSTEMS

.1 Flush system.

.2 Before start-up, clean interior of piping systems.

.3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

.1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.

.2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.

.3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.

.4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.

.5 Conduct tests in presence of Departmental Representative.

.6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.

.7 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

3.13 EXISTING SYSTEMS

.1 Connect into existing piping systems at times approved by Departmental Representative.

.2 Request written approval by Departmental Representative10 days minimum, prior to commencement of work.

.3 Be responsible for damage to existing plant by this work.

3.14 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for recycling

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Electrical motors, drives and guards for mechanical equipment and systems.

.2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.

.3 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 22 and 23. Refer to Division 26 for quality of materials and workmanship.

1.2 REFERENCES

.1 National Energy Code of Canada (NECC).

.2 Electrical Equipment Manufacturers' Association Council (EEMAC)

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.3 Closeout Submittals

.1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

.1 Regulatory Requirements: work to be performed in compliance with applicable Provincial /Territorial regulations.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for recylcing

Part 2 Products

2.1 GENERAL

.1 Motors: high efficiency, in accordance with local Hydro company standards and to NECC.

2.2 MOTORS

.1 Provide motors for mechanical equipment as specified.

.2 Motors under 373 W (1/2 HP) : speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.

.3 Motors 373 W (1/2 HP) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 degrees C, 3 phase, unless otherwise indicated.

2.3 TEMPORARY MOTORS

.1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Departmental Representative for temporary use. Work will only be accepted when specified motor is installed.

2.4 BELT DRIVES

.1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.

.2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.

.3 For motors under 7.5 kW (10 HP): standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.

.4 For motors 7.5 kW (10 HP) and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.

.5 Correct size of sheave determined during commissioning.

.6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.

.7 Motor slide rail adjustment plates to allow for centre line adjustment.

.8 Supply one set of spare belts for each set installed.

2.5 DRIVE GUARDS

.1 Provide guards for unprotected drives.

.2 Guards for belt drives;

.1 Expanded metal screen welded to steel frame.

.2 Minimum 1.2 mm thick sheet metal tops and bottoms.

.3 38 mm dia holes on both shaft centres for insertion of tachometer.

.4 Removable for servicing.

.3 Provide means to permit lubrication and use of test instruments with guards in place.

.4 Install belt guards to allow movement of motors for adjusting belt tension.

.1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.

.2 Securely fasten in place.

.3 Removable for servicing.

.5 Unprotected fan inlets or outlets:

.1 Wire or expanded metal screen, galvanized, 19 mm mesh.

.2 Net free area of guard: not less than 80% of fan openings.

.3 Securely fasten in place.

.4 Removable for servicing.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Fasten securely in place.

.2 Make removable for servicing, easily returned into, and positively in position.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule site visits, to review Work.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International Inc.

.1 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

.2 ASTM A105/A105M, Standard Specification for Carbon Steel Forgings, for Piping Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.

.1 Manufacturer, model number, line contents, pressure and temperature rating.

.2 Movement handled, axial, lateral, angular and the amounts of each.

.3 Nominal size and dimensions including details of construction and assembly.

1.3 CLOSEOUT SUBMITTALS

.1 Provide maintenance and operation data in accordance with Section 01 78 00 - Closeout Submittals.

.1 Data to include:

.1 Servicing requirements, including special requirements, stuffing box packing, lubrication and recommended procedures.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with manufacturer’s recommendations

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and recycling

Part 2 Products

2.1 SLIP TYPE EXPANSION JOINTS

.1 Application: for axial pipe movement, as indicated.

.2 Repacking: under full line pressure.

.3 Body and packing housings: carbon steel pipe to ASTM A53/A53M, Grade B. Wall thickness to match pipe with flanges to match pipe.

.4 Slip or traverse sleeves: carbon steel pipe to ASTM A53/A53M, Grade B, hard chrome plated.

.5 Anchor base: construction steel, welded to body.

.6 Guides (internal and external): embody into packing housing with concentric alignment of slip or traverse sleeve with packing housing.

.7 Extension limit stop: stainless steel, to prevent over-extension with accessible and removable pins.

.8 Packing rings: 6 minimum, PTFE or graphite impregnated non-asbestos.

.9 Thermal plastic packing: PTFE or graphite impregnated non-asbestos slug supplied loose.

.10 Lubricating fittings: pet cocks with grease nipple.

.11 Plunger body and plunger:

.1 Plunger body: heavy wall carbon steel welded to body.

.2 Plunger: carbon steel with hex head for use with socket wrench.

.12 Lubricant: to manufacturer's recommendations.

.13 Lubricant gun: complete with hose assembly.

.14 [Drip connection: 20 MPa forged steel to ASTM A105/A105M. Include half coupling with drain plug].

2.2 BELLOWS TYPE EXPANSION JOINTS

.1 For axial, lateral or angular movements, as indicated.

.2 Maximum operating pressure: to suite system being installed in.

.3 Maximum operating temperature: to suite system being installed in.

.4 Type A: controlled flexing, factory tested to 1 times maximum working pressure. Provide test certificates.

.5 Type B: externally pressurized, factory tested to 1 times maximum working pressure. Provide test certificates.

.6 Bellows:

.1 Multiple bellows, hydraulically formed, two ply, austenitic stainless steel for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.

.7 Reinforcing or control rings:

.1 2 piece nickel iron.

.8 Ends:

.1 Flanges to match pipe.

.9 Liner:

.1 Austenitic stainless steel in direction of flow.

.10 Shroud:

.1 Carbon steel, painted.

2.3 GROOVED END EXPANSION JOINTS

.1 Packless, Gasketted, Slip, Expansion Joints:

.1 2413 kPa maximum working pressure.

.2 Steel pipe fitting consisting of telescoping body and slip-pipe sections.

.3 PTFE modified polyphenylene sulfide coated slide section.

.4 Suitable for axial end movement to 75 mm.

.2 Expansion joint consisting of series of grooved end pipe nipples joined in tandem with flexible couplings. Total joint movement dependent on number of couplings and nipples used.

2.4 FLEXIBLE CONNECTION

.1 Application: to suit anticipated motion.

.2 Minimum length in accordance with manufacturer's recommendations.

.3 Inner hose: stainless steel corrugated.

.4 Braided wire mesh stainless steel outer jacket.

.5 Diameter and type of end connection: as indicated.

.6 Operating conditions:

.1 To match system requirements.

.7 Three flexible grooved couplings placed in close proximity to vibration source for vibration attenuation and stress relief.

2.5 ANCHORS AND GUIDES

.1 Anchors:

.1 Provide as required.

.2 Alignment guides:

.1 Provide as required.

.2 To accommodate specified thickness of insulation.

.3 Vapour barriers, jackets to remain uninterrupted.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

.1 Install expansion joints with cold setting. Make record of cold settings.

.2 Install expansion joints and flexible connections in accordance with manufacturer's instructions.

.3 Install pipe anchors and guides as indicated. Anchors to withstand 150% of axial thrust.

3.3 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.2 Waste Management: separate waste materials for recycling.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and components for metering steam and chilled/hot water including installation.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)

.1 ASME Fluid Meter's Handbook: Their Theory and Application, Latest Edition.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.3 Submittals to include:

.1 Piping configuration and sizing - straight pipe upstream and downstream, distances to first weld, protrusion, thermowell, pressure tap.

.2 Service conditions.

.3 Full details of primary element - standard of design and construction, materials, type serial number, flow rate, differential pressure, irrecoverable head loss (IHL), calculation sheets.

.4 Accuracy statements for each component at specified flow rates and other conditions.

.5 Flow and temperature ranges.

.6 Signal processor calibration data.

.7 Minimum turndown ratio.

.4 Closeout Submittals:

.1 Submit maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling

Part 2 Products

2.1 ACCURACY

.1 Calculate overall accuracy of each installation using following expression: Overall accuracy = (E (accuracy of individual components of system)^2)1/2.

.2 Components to include:

.1 Primary flow measuring elements.

.2 Transmitters: flow, differential pressure, pressure, temperature, temperature difference.

.3 RTD's.

.4 Signal processors, recorders.

.5 Calibration of signal processors: assume 0.20% per processor.

.6 Installation tolerances: assume 1% for concentricity of pipe, difference in height of transmitter piping.

.3 Show in proposal overall accuracy at 100%, 70%, 10%, minimum specified design flow rate.

.4 Indicate minimum measurable flow rate.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION OF DIFFERENTIAL PRESSURE TAPS AND PIPING

.1 Differential pressure taps horizontal and level with each other to within +/- 1.5 mm.

.2 Tubing: straight, supported throughout its length, sloped 5%-10% upward to main for drainage and venting, without air pockets, with blowdown valves at bottom.

3.3 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B31.1, Power Piping.

.2 ASTM International

.1 ASTM A125, Standard Specification for Steel Springs, Helical, Heat-Treated.

.2 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.3 ASTM A563, Standard Specification for Carbon and Alloy Steel Nuts.

.3 Factory Mutual (FM)

.4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)

.1 MSS SP58, Pipe Hangers and Supports - Materials, Design and Manufacture.

.2 MSS SP69, Pipe Hangers and Supports - Selection and Application.

.3 MSS SP89, Pipe Hangers and Supports - Fabrication and Installation Practices.

.5 Underwriter's Laboratories of Canada (ULC)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit shop drawings for:

.1 Bases, hangers and supports.

.2 Connections to equipment and structure.

.3 Structural assemblies.

1.3 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and recycling

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Design Requirements:

.1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.

.2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.

.3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.

.4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.

.5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

2.2 GENERAL

.1 Fabricate hangers, supports and sway braces in accordance with MSS SP58.

2.3 PIPE HANGERS

.1 Finishes:

.1 Pipe hangers and supports: galvanized.

.2 Ensure steel hangers in contact with copper piping are copper plated.

.2 Upper attachment structural: suspension from lower flange of I-Beam:

.1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut.

.1 Rod: 9 mm UL listed.

.2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed to MSS-SP58.

.3 Upper attachment structural: suspension from upper flange of I-Beam:

.1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed to MSS SP69.

.2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed.

.4 Upper attachment to concrete:

.1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.

.2 Concrete inserts: wedge shaped body with knockout protector plate UL listed to MSS SP69.

.5 Hanger rods: threaded rod material to MSS SP58:

.1 Ensure that hanger rods are subject to tensile loading only.

.2 Provide linkages where lateral or axial movement of pipework is anticipated.

.6 Pipe attachments: material to MSS SP58:

.1 Attachments for steel piping: carbon steel galvanized.

.2 Attachments for copper piping: copper plated black steel.

.3 Use insulation shields for hot pipework.

.4 Oversize pipe hangers and supports.

.7 Adjustable clevis: material to MSS SP69, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.

.1 Ensure "U" has hole in bottom for rivetting to insulation shields.

.8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.

.9 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.

.1 Finishes for steel pipework: galvanized.

.2 Finishes for copper, glass, brass or aluminum pipework: galvanized, with formed portion plastic coated.

.10 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.4 RISER CLAMPS

.1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42.

.2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.

.3 Bolts: to ASTM A307.

.4 Nuts: to ASTM A563.

2.5 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:

.1 64 kg/m^3 density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.

.2 Insulated hot piping:

.1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

2.6 CONSTANT SUPPORT SPRING HANGERS

.1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).

.2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.

.3 Provide upper and lower factory set travel stops.

.4 Provide load adjustment scale for field adjustments.

.5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.

.6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.7 VARIABLE SUPPORT SPRING HANGERS

.1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.

.2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.

.3 Variable spring hanger complete with factory calibrated travel stops.

.4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.8 EQUIPMENT SUPPORTS

.1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings. Submit calculations with shop drawings.

2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

.1 Provide templates to ensure accurate location of anchor bolts.

2.10 PLATFORMS AND CATWALKS

.1 To Section 05 50 00 - Metal Fabrications.

2.11 HOUSE-KEEPING PADS

.1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 150 mm larger than equipment; chamfer pad edges.

.2 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.

2.12 OTHER EQUIPMENT SUPPORTS

.1 Fabricate equipment supports from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings.

.2 Submit structural calculations with shop drawings.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install in accordance with:

.1 Manufacturer's instructions and recommendations.

.2 Vibration Control Devices:

.1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.

.3 Clamps on riser piping:

.1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.

.2 Bolt-tightening torques to industry standards.

.3 Steel pipes: install below coupling or shear lugs welded to pipe.

.4 Cast iron pipes: install below joint.

.4 Clevis plates:

.1 Attach to concrete with 4 minimum concrete inserts, 1 at each corner.

.5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

.6 Use approved constant support type hangers where:

.1 Vertical movement of pipework is 13 mm or more,

.2 Transfer of load to adjacent hangers or connected equipment is not permitted.

.7 Use variable support spring hangers where:

.1 Transfer of load to adjacent piping or to connected equipment is not critical.

.2 Variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

.1 Plumbing piping: to Canadian Plumbing Code.

.2 Fire protection: to applicable fire code.

.3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.

.4 Copper piping: up to NPS 1/2: every 1.5 m.

.5 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.

.6 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m
5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	
12	4.9 m	

.7 Pipework greater than NPS 12: to MSS SP69.

3.4 HANGER INSTALLATION

.1 Install hanger so that rod is vertical under operating conditions.

.2 Adjust hangers to equalize load.

.3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

3.5 HORIZONTAL MOVEMENT

.1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.

.2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.6 FINAL ADJUSTMENT

.1 Adjust hangers and supports:

.1 Ensure that rod is vertical under operating conditions.

.2 Equalize loads.

.2 Adjustable clevis:

.1 Tighten hanger load nut securely to ensure proper hanger performance.

.2 Tighten upper nut after adjustment.

.3 C-clamps:

.1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.

.4 Beam clamps:

.1 Hammer jaw firmly against underside of beam.

3.7 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for recylcing

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Vibration isolation materials and components, seismic control measures and their installation.

1.2 REFERENCES

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.2 National Fire Protection Association (NFPA)

.1 NFPA 13-[2002], Standard for the Installation of Sprinkler Systems.

.3 National Building Code of Canada (NBC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for recylcing

Part 2 Products

2.1 GENERAL

.1 Size and shape of bases type and performance of vibration isolation as indicated.

2.2 ELASTOMERIC PADS

.1 Type EP1 - neoprene waffle or ribbed; 9 mm minimum thick; 50 durometer; maximum loading 350 kPa.

.2 Type EP2 - rubber waffle or ribbed; 9 mm minimum thick; 30 durometer natural rubber; maximum loading 415 kPa.

.3 Type EP3 - neoprene-steel-neoprene; 9 mm minimum thick neoprene bonded to 1.71 mm steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa.

.4 Type EP4 - rubber-steel-rubber; 9 mm minimum thick rubber bonded to 1.71 mm steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa.

2.3 ELASTOMERIC MOUNTS

.1 Type M1 - colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.

2.4 SPRINGS

.1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.

.2 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.

.3 Cadmium plate for 100% relative humidity installations.

.4 Colour code springs.

2.5 SPRING MOUNT

.1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.

.2 Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.

.3 Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.

.4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.

.5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.

2.6 HANGERS

.1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.

.2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.

.3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.

.4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.

.5 Type H4 - stable spring, elastomeric element with precompression washer and nut with deflection indicator.

2.7 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

.1 Acoustic barriers: between pipe and support, consisting of 25 mm minimum thick heavy duty duck and neoprene isolation material.

2.8 HORIZONTAL THRUST RESTRAINT

.1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 9 mm.

.2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.

2.9 STRUCTURAL BASES

.1 Type B1 - Prefabricated steel base: integrally welded on sizes up to 2400 mm on smallest dimension, split for field welding on sizes over 2400 mm on smallest dimension and reinforced for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; pre-drilled holes to receive equipment anchor bolts; and complete with adjustable built-in motor slide rail where indicated.

.2 Type B2 - Steel rail base: structural steel, positioned for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; and pre-drilled holes to receive equipment anchor bolts.

.3 Bases to clear housekeeping pads by 25 mm minimum.

2.10 INERTIA BASE

.1 Type B3 - Full depth perimeter structural or formed channels, frames: welded in place reinforcing rods running in both directions; spring mounted, carried by gussetted height-saving brackets welded to frame; and clear housekeeping pads by 50 mm minimum.

.2 Pump bases: "T" shaped, where applicable, to provide support for elbows.

.3 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.

2.11 ROOF CURB ISOLATION RAILS

.1 General: complete factory assembled without need for sub-base.

.2 Lower member: continuous rectangular steel tube.

.3 Upper member: continuous rectangular steel tube to provide continuous support for equipment, complete with all-directional neoprene snubber bushings 6 mm thick to resist wind forces.

.4 Springs: steel, adjustable, removable, selected for 25 mm maximum static deflection plus 50% additional travel to solid, cadmium plated, sized and positioned to ensure uniform deflection.

.5 High frequency isolation: 6 mm minimum thick continuous gasket on top and bottom of complete assembly. Material: closed cell neoprene.

.6 Weatherproofing: continuous flexible counterflashing to curb and providing access to springs. Material: aluminum.

.7 Hardware: cadmium plated or galvanized.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install vibration isolation equipment in accordance with manufacturer’s instructions and adjust mountings to level equipment.

.2 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.

.3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:

.1 Up to NPS4: first 3 points of support. NPS5 to NPS8: first 4 points of support. NPS10 and Over: first 6 points of support.

.2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.

.4 Where isolation is bolted to floor use vibration isolation rubber washers.

.5 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.

.2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.2 QUALIFICATIONS OF TAB PERSONNEL

.1 Submit names of personnel to perform TAB to Departmental Representative within 30 days of award of contract.

.2 Provide documentation confirming qualifications, successful experience.

.3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:

.1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1.

.2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing.

.4 Recommendations and suggested practices contained in the TAB Standard: mandatory.

.5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.

.6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.

.7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.

.8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.

.1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.

.2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 PURPOSE OF TAB

.1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads

.2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 EXCEPTIONS

.1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

1.5 CO-ORDINATION

.1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.

.2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.6 PRE-TAB REVIEW

.1 Review contract documents before project construction is started confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report to Departmental Representative in writing proposed procedures which vary from standard.

.3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7 START-UP

.1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

.2 Follow special start-up procedures specified elsewhere in Division 23.

1.8 OPERATION OF SYSTEMS DURING TAB

.1 Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.

1.9 START OF TAB

.1 Notify Departmental Representative 7 days prior to start of TAB.

.2 Start TAB when building or renovation area is essentially completed, including:

.3 Installation of ceilings, doors, windows, other construction affecting TAB.

.4 Application of weather-stripping, sealing, and caulking.

.5 Pressure, leakage, other tests specified elsewhere Division 23.

.6 Provisions for TAB installed and operational.

.7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

.1 Proper thermal overload protection in place for electrical equipment.

.2 Air systems:

.1 Filters in place, clean.

.2 Duct systems clean.

.3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.

.4 Correct fan rotation.

.5 Fire, smoke, volume control dampers installed and open.

.6 Coil fins combed, clean.

.7 Access doors, installed, closed.

.8 Outlets installed, volume control dampers open.

.3 Liquid systems:

.1 Flushed, filled, vented.

.2 Correct pump rotation.

.3 Strainers in place, baskets clean.

.4 Isolating and balancing valves installed, open.

.5 Calibrated balancing valves installed, at factory settings.

.6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:

.1 HVAC systems: plus 10 %, minus 10 %.

.2 Hydronic systems: plus or minus 10 %.

1.11 ACCURACY TOLERANCES

.1 Measured values accurate to within plus or minus 2 % of actual values.

1.12 INSTRUMENTS

.1 Prior to TAB, submit to Departmental Representative list of instruments.

.2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

.3 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.

1.13 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit, prior to commencement of TAB:

.2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.14 PRELIMINARY TAB REPORT

.1 Submit for checking and approval of Departmental Representative prior to submission of formal TAB report, sample of rough TAB sheets. Include:

.1 Details of instruments used.

.2 Details of TAB procedures employed.

.3 Calculations procedures.

.4 Summaries.

1.15 TAB REPORT

.1 Format in accordance with [referenced standard].

.2 TAB report to show results in SI units and to include:

.1 Project record drawings.

.2 System schematics.

.3 Submit 6 copies of TAB Report to Departmental Representativefor verification and approval, in D-ring binders, complete with index tabs.

1.16 VERIFICATION

.1 Reported results subject to verification by Departmental Representative.

.2 Provide personnel and instrumentation to verify up to 30 % of reported results.

.3 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

1.17 SETTINGS

.1 After TAB is completed to satisfaction of Departmental Representative replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.

.2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.18 COMPLETION OF TAB

.1 TAB considered complete when final TAB Report received and approved by Departmental Representative.

1.19 AIR SYSTEMS

.1 Standard: TAB to most stringent of TAB standards of AABC and NEBB.

.2 Do TAB of following systems, equipment, components, controls:

.1 Firing range Supply Air AHU, including:

.1 Total air flow and pressure at AHU intake and discharge.

.2 Total air flow and pressure at main duct entering firing range

.3 Air flow at each supply air grille/outlet in supply air plenum wall located in range.

.4 Measure air flow velocity at maximum AHU flow rate at the firing line in each lane and at 5 equally spaced heights, per lane.

.5 Flow rate and pressure drop into all hydronic coils, including reclaim coil.

.6 Air flow to all other supply air outlets.

.2 Firing range Exhaust Air AHU, including:

.1 Total air flow and pressure at AHU inlet and discharge.

.1 Also measure:

.1 Air flow and pressure at exhaust air duct at back of range where it enters into the firing range and air flow to each inlet on this duct.

.2 Total air flow and pressure at exhaust duct entering firing range 5 meters in front of the firing line.

.3 Air flow at each exhaust air inlet 5 meters in front of the firing line.

.4 Measure air flow velocity at maximum AHU flow rate at the firing line in each lane and at 5 equally spaced heights, per lane.

.5 Flow rate and pressure drop into reclaim coil.

.3 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.

.4 Locations of equipment measurements: to include as appropriate:

.1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.

.2 At controllers, controlled device.

.5 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 OTHER TAB REQUIREMENTS

.1 General requirements applicable to work specified this paragraph:

.1 Qualifications of TAB personnel: as for air systems specified this section.

.2 Quality assurance: as for air systems specified this section.

.2 Room pressure conditions:

.1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.

.1 Firing range shall operate on a flow differential between supply and exhaust air

.2 Entrance vestibule shall have a positive pressure with differential pressure monitoring.

.3 Smoke management systems:

.1 Test for proper operation of all smoke and fire dampers installed as component parts of air systems specified Division 23.

1.21 POST-OCCUPANCY TAB

.1 Measure air velocity, air flow patterns, in occupied zone of following areas: firing range.

.2 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 1 month of termination of Warranty Period.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and methods for pressure testing ducts over 5 m in length, forming part of a supply, return or exhaust ductwork system directly or indirectly connected to air handling equipment.

1.2 REFERENCES

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)

.1 SMACNA HVAC Air Duct Leakage Test Manual.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Test Reports: submit test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties. Include pressure test information and results as follows:

.1 Submit proposed report form and test report format to Departmental Representative for approval at least [three] months before proposed date of first series of tests. Do not start tests until approval received in writing from Departmental Representative.

.2 Prepare report of results and submit to Departmental Representative within 4 business days of completion of tests. Include:

.1 Schematic of entire system.

.2 Schematic of section under test showing test site.

.3 Required and achieved static pressures.

.4 Orifice differential pressure at test sites.

.5 Permissible and actual leakage flow rate (L/s) for test sites.

.6 Witnessed certification of results.

.3 Include test reports in final TAB report.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Instructions: submit manufacturer's installation instructions.

.6 Manufacturer's field reports specified.

Part 2 Products

2.1 TEST INSTRUMENTS

.1 Test apparatus to include:

.1 Fan capable of producing required static pressure.

.2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.

.3 Flow measuring instrument compatible with the orifice plate.

.4 Calibration curves for orifice plates used.

.5 Flexible duct for connecting to ductwork under test.

.6 Smoke bombs for visual inspections.

.2 Test apparatus: accurate to within +/- 3 % of flow rate and pressure.

.3 Submit details of test instruments to be used to Departmental Representative at least one months before anticipated start date.

.4 Test instruments: calibrated and certificate of calibration deposited with Departmental Representative no more than 7 days before start of tests.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 TEST PROCEDURES

.1 Maximum lengths of ducts to be tested consistent with capacity of test equipment.

.2 Section of duct to be tested to include:

.1 Fittings, branch ducts, tap-ins.

.3 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.

.4 Base partial system leakage calculations on SMACNA HVAC Air Duct Leakage Test Manual.

.5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

.6 Test new installed ductwork and isolate from existing ductwork during testing.

.7 Note: existing exhaust and supply ductwork may contain lead particles. Do not positively pressurize existing ductwork at any point during testing.

3.3 SITE TOLERANCES

.1 System leakage tolerances specified are stated as percentage of total flow rate handled by system. Pro-rate specified system leakage tolerances. Leakage for sections of duct systems: not to exceed total allowable leakage.

.2 Leakage tests on following systems not to exceed specified leakage rates.

.1 Small duct systems up to 250 Pa: leakage 2%.

.2 VAV box and duct on downstream side of VAV box: leakage 2%.

.3 Large low pressure duct systems up to 500 Pa: leakage 2%.

.4 HP duct systems up to 1000 Pa pressure classification, including upstream side of VAV boxes: leakage 1%.

.3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 TESTING

.1 Test ducts before installation of insulation or other forms of concealment.

.2 Test after seals have cured.

.3 Test when ambient temperature will not affect effectiveness of seals, and gaskets.

.4 Flexible connections to VAV boxes.

3.5 CLEANING

.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Definitions:

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED" - means "not concealed" as previously defined.

.3 Insulation systems - insulation material, fasteners, jackets, and other accessories.

.2 TIAC Codes:

.1 CRD: Code Round Ductwork,

.2 CRF: Code Rectangular Finish.

.2 Reference Standards:

.1 National Energy Code of Canada (NECC).

.2 ASTM International Inc.

.1 ASTM B209M, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

.2 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.

.3 ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.5 ASTM C547, Standard Specification for Mineral Fiber Pipe Insulation.

.6 ASTM C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.7 ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.8 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.9 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).

.5 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Manufacturers' Instructions:

.1 Provide manufacture's written duct insulation jointing recommendations.

1.3 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, member of TIAC.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with manufacturer’s recommendations.

.2 Packaging Waste Management: remove for reuse and recycling.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 To CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).

.4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).

.1 Mineral fibre: to ASTM C553.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to ASTM C553.

2.3 JACKETS

.1 Canvas:

.1 220 gm/m^2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

.2 Lagging adhesive: compatible with insulation.

.3 Aluminum:

.1 To ASTM B209 without moisture barrier as scheduled in PART 3 of this section.

.2 Thickness: 0.50 mm sheet.

.3 Finish: Stucco embossed.

.4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

.4 Stainless steel:

.1 Type: 304 or 316.

.2 Thickness: 0.50 mm sheet.

.3 Finish: Stucco embossed.

.4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

2.4 ACCESSORIES

.1 Vapour retarder lap adhesive:

.1 Water based, fire retardant type, compatible with insulation.

.2 Indoor Vapour Retarder Finish:

.1 Vinyl emulsion type acrylic, compatible with insulation.

.3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.

.4 ULC Listed Canvas Jacket:

.1 220 gm/m^2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

.5 Outdoor Vapour Retarder Mastic:

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m^2.

.6 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.

.7 Contact adhesive: quick-setting

.8 Canvas adhesive: washable.

.9 Tie wire: 1.5 mm stainless steel.

.10 Banding: 19 mm wide, 0.5 mm thick stainless steel.

.11 Facing: 25 mm stainless steel hexagonal wire mesh stitched on one face of insulation with expanded metal lath on other face.

.12 Fasteners: 4 mm diameter pins with 35 mm diameter clips, length to suit thickness of insulation.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 PRE-INSTALLATION REQUIREMENTS

.1 Pressure test ductwork systems complete, witness and certify.

.2 Ensure surfaces are clean, dry, and free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturer’s instructions and as indicated.

.3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Ensure hangers, and supports are outside vapour retarder jacket.

.5 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

.1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.

.6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum [2] rows each side.

3.4 DUCTWORK INSULATION SCHEDULE

.1 Insulation types and thicknesses: conform to following table:

TIAC Code	Type	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	yes	50
Round cold and dual temperature supply air ducts	C-2	yes	50
Rectangular warm air ducts	C-1	no	25
Round warm air ducts	C-1	no	25
Supply, return and exhaust ducts exposed in space being served	none		
Outside air ducts to mixing plenum	C-1	yes	25
Mixing plenums	C-1	yes	25
Exhaust duct between	C-1	no	25

dampers and louvres			
Rectangular ducts outside	C-1	special	[50]
Round ducts outside	C-1	special	[50]

.2 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:

.1 Use TIAC code C-1 insulation, scored to suit diameter of duct.

.1 Finishes: conform to following table:

TIAC Code		
Rectangular	Round	
Indoor, concealed	none	none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3
Outdoor, exposed to precipitation	CRF/3	CRD/4
Outdoor, elsewhere	CRF/4	CRD/5

3.5 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for recycling

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Thermal insulation for piping and piping accessories in commercial type applications.

1.2 REFERENCES

.1 National Energy Code of Canada (NECC).

.2 American Society for Testing and Materials International (ASTM)

.1 ASTM B209M, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate.

.2 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.3 ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.5 ASTM C533, Calcium Silicate Block and Pipe Thermal Insulation.

.6 ASTM C547, Mineral Fiber Pipe Insulation.

.7 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.8 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.2 CAN/CGSB-51.53, Poly (Vinyl Chloride) Jacketting Sheet, for Insulated Pipes, Vessels and Round Ducts

.4 Department of Justice Canada (Jus)

.1 Canadian Environmental Assessment Act (CEAA).

.2 Canadian Environmental Protection Act (CEPA).

.3 Transportation of Dangerous Goods Act (TDGA).

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.6 Manufacturer's Trade Associations

.1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.

.7 Underwriters' Laboratories of Canada (ULC)

.1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701, Thermal Insulation, Polystyrene, Boards and Pipe Covering.

.3 CAN/ULC-S702, Thermal Insulation, Mineral Fibre, for Buildings

.4 CAN/ULC-S702.2, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.3 DEFINITIONS

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED" - will mean "not concealed" as specified.

.2 TIAC ss:

.1 CRF: Code Rectangular Finish.

.2 CPF: Code Piping Finish.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.3 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.4 Samples:

.1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.

.5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

.1 Qualifications:

.2 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, member of TIAC.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.2 Storage and Protection:

.1 Protect from weather, construction traffic.

.2 Protect against damage.

.3 Store at temperatures and conditions required by manufacturer.

.3 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling

.2 Place excess or unused insulation and insulation accessory materials in designated containers.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC-S102.

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre specified includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702.

.2 Maximum "k" factor: to CAN/ULC-S702.

.4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to CAN/ULC-S702.

.5 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).

.1 Mineral fibre: to CAN/ULC-S702.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to CAN/ULC-S702.

.6 TIAC Code A-6: flexible unicellular tubular elastomer.

.1 Insulation: with vapour retarder jacket.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

.7 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.

.1 Insulation: to ASTM C533.

.2 Design to permit periodic removal and re-installation.

2.3 INSULATION SECUREMENT

.1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5 mm diameter stainless steel.

.5 Bands: stainless steel, 19 mm wide, 0.5 mm thick.

2.4 CEMENT

.1 Thermal insulating and finishing cement:

.1 Hydraulic setting on mineral wool, to ASTM C449/C449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

.1 Water based, fire retardant type, compatible with insulation.

2.6 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 OUTDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: fibrous glass, untreated 305 g/m^2.

2.8 JACKETS

.1 Polyvinyl Chloride (PVC):

.1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.

.2 Colours: to match adjacent finish paint.

.3 Minimum service temperatures: -20 degrees C.

.4 Maximum service temperature: 65 degrees C.

.5 Moisture vapour transmission: 0.02 perm.

.6 Thickness:0.75 mm.

.7 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.2 ABS Plastic:

.1 One-piece moulded type and sheet with pre-formed shapes as required.

.2 Colours: to match adjacent finish paint.

.3 Minimum service temperatures: -40 degrees C.

.4 Maximum service temperature: 82 degrees C.

.5 Moisture vapour transmission: 0.012 perm.

.6 Thickness: 0.75 mm.

.7 Fastenings:

.1 Solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.8 Locations:

.1 For outdoor use ONLY.

.3 Canvas:

.1 220 and 120 gm/m^2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

.2 Lagging adhesive: compatible with insulation.

.4 Aluminum:

.1 To ASTM B209.

.2 Thickness: 0.50 mm sheet.

.3 Finish: stucco embossed.

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

.5 Stainless steel:

.1 Type: 304 or 316.

.2 Thickness: 0.25 mm.

.3 Finish: stucco embossed.

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5mm thick at 300 mm spacing.

2.9 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

.1 Caulking to: Section 07 92 00 - Joint Sealants.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 PRE-INSTALLATION REQUIREMENT

.1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturer’s instructions and this specification.

.3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Install hangers, supports outside vapour retarder jacket.

.5 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: at expansion joints, valves, primary flow measuring elements, flanges and unions at equipment.

.2 Design: to permit movement of expansion joint, permit periodic removal and replacement without damage to adjacent insulation.

.3 Insulation:

.1 Insulation, fastenings and finishes: same as system.

3.5 INSTALLATION OF ELASTOMERIC INSULATION

.1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.

.2 Provide vapour retarder as recommended by manufacturer.

3.6 PIPING INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 TIAC Code: A-1.

.1 Securements: SS bands at 300 mm on centre.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code 1501-H.

.3 TIAC Code: A-3.

.1 Securements: SS bands at 300 mm on centre.

.2 Seals: VR lap seal adhesive, VR lagging adhesive.

.3 Installation: TIAC Code: 1501-C.

.4 TIAC Code: A-6.

.1 Insulation securements: as recommended by manufacturer.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: as recommended by manufacturer.

.5 TIAC Code: C-2 with vapour retarder jacket.

.1 Insulation securements: as recommended by manufacturer.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code: 1501-C.

.6 TIAC Code: A-2.

.1 Insulation securements: as recommended by manufacturer.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code: 1501-H.

.7 Thickness of insulation as listed in following table.

.1 Run-outs to individual units and equipment not exceeding 4000 mm long.

.2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

.3

Application	Temp degrees C	TIAC code	Insulation thickness (mm)
Hot Water Heating	60 - 94	A-1	25
Hot Water Heating	up to 59	A-1	25
Glycol Heating	60 - 94	A-1	25
Glycol Heating	up to 59	A-1	25
Chilled Water	4 - 13	A-3	25
Chilled Water or Glycol	below 4	A-3	25
Refrigerant	4 - 13	A-6	25

.8 Finishes:

.1 Exposed indoors: canvas.

.2 Exposed in mechanical rooms: canvas.

.3 Concealed, indoors: canvas on valves, fittings. No further finish.

.4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.

.5 Outdoors: water-proof aluminum jacket.

.6 Finish attachments: SS bands, at 150 mm on centre.

.7 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Procedures and cleaning solutions for cleaning mechanical piping systems.

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM E202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling.

Part 2 Products

2.1 CLEANING SOLUTIONS

.1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.

.2 Sodium carbonate: 0.40 kg per 100 L water in system.

.3 Low-foaming detergent: 0.01 kg per 100 L water in system.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 CLEANING HYDRONIC AND STEAM SYSTEMS

.1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.

.2 Cleaning Agency:

.1 Retain qualified water treatment specialist to perform system cleaning.

.3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete [by water treatment specialist].

.4 Cleaning procedures:

.1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:

.1 Cleaning procedures, flow rates, elapsed time.

.2 Chemicals and concentrations used.

.3 Inhibitors and concentrations.

.4 Specific requirements for completion of work.

.5 Special precautions for protecting piping system materials and components.

.6 Complete analysis of water used to ensure water will not damage systems or equipment.

.5 Conditions at time of cleaning of systems:

.1 Systems: free from construction debris, dirt and other foreign material.

.2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.

.3 Strainers: clean prior to initial fill.

.4 Install temporary filters on pumps not equipped with permanent filters.

.5 Install pressure gauges on strainers to detect plugging.

.6 Report on Completion of Cleaning:

.1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

.7 Hydronic Systems:

.1 Fill system with water, ensure air is vented from system.

.2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).

.3 Use water metre to record volume of water in system to +/- 0.5%.

.4 Add chemicals under direct supervision of chemical treatment supplier.

.5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.

.6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.

.7 Add chemical solution to system.

.8 Establish circulation, raise temperature slowly to [maximum design] [82 degrees C minimum]. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

.8 Glycol Systems:

.1 In addition to procedures specified above perform specified procedures.

.2 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E202.

.9 Steam Systems: in addition to general requirements as specified above, perform following:

.1 Remove internal components of steam traps until flushing and warm-up have been completed.

.2 Open drip points to atmosphere. If needed for protection of personnel or environment, install flexible hose and direct discharge to safe location.

.3 Starting at drip point closest to source, verify removal of condensate, then re-install steam trap internal parts. Repeat sequence down the line.

.4 Water hammer: determine source and eliminate cause.

3.3 START-UP OF HYDRONIC SYSTEMS

.1 After cleaning is completed and system is filled:

.1 Establish circulation and expansion tank level, set pressure controls.

.2 Ensure air is removed.

.3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.

.4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.

.5 Clean out strainers repeatedly until system is clean.

.6 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.

.7 Repeat with water at design temperature.

.8 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.

.9 Bring system up to design temperature and pressure slowly.

.10 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.11 Adjust pipe supports, hangers, springs as necessary.

.12 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.

.13 If sliding type expansion joints bind or bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.

.14 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.

.15 Check operation of drain valves.

.16 Adjust valve stem packings as systems settle down.

.17 Fully open balancing valves (except those that are factory-set).

.18 Check operation of over-temperature protection devices on circulating pumps.

.19 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section includes:

.1 Material and installation for DDC (direct digital control) controller for new HVAC equipment and interface with existing building DDC system.

1.2 WORK INCLUDED

.1 Provide DDC equipment for control of new HVAC equipment, to match existing and integrate with existing on-site control system and connect directly to the existing network(s) and existing web-server operator interface software.

.2 Include complete system of hardware and software as manufactured by the existing controls system manufacturer already in the building. Components and interconnecting systems to be installed by trained technicians, regularly employed in the Controls industry.

.3 Data communication network to link Systems Controllers, Application Controllers and network devices together and to the existing Operators Interface Web-Server application.

.1 The intent is to provide a complete working system for control of new equipment which interfaces and connects to the existing building DDC system.

1.3 QUALITY ASSURANCE

.1 Contractor/Manufacturer Qualifications:

.1 The Installer shall have an established working relationship with the Control System Manufacturer, and be the authorized representative of the Manufacturer at bid time.

.2 The Installer shall have successfully completed Control System Manufacturer's classes on the control system. The Installer shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.

.3 All products used in this installation shall be new, currently under manufacture, and shall be applied in standard off the shelf products. This installation shall not be used as a test site for any new products unless explicitly approved by the Engineer in writing. Spare parts shall be available for at least 5 years after completion of this contract.

1.4 CODES AND STANDARDS

.1 All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, provincial, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications.

1.5 WARRANTY

.1 Warrant all work as follows:

.1 Labor and materials for the control system specified shall be warranted free from defects for a period of 2 years after final completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner. Repairs required by a total system failure, or the malfunction of any priority portion of the system shall be considered an emergency repair, and shall be performed within eight (8) hours of the report of the failures. Repairs of a non-emergency nature shall be promptly repaired on the next business day.

1.6 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.

.2 Provide information on warranty.

1.7 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

Part 2 Products

2.1 MATERIALS

.1 All products used in this project installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of two years. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's Representative in writing. Spare parts shall be available for at least five years after completion of this contract.

2.2 COMMUNICATION

.1 All control products provided for this project shall comprise a BACnet internetwork. Communication involving control components (i.e., all types of controllers and Operator Workstations) shall conform to ANSI/ASHRAE Standard 135-2001, BACnet.

.2 Each BACnet device shall operate on the BACnet Data Link/Physical layer protocol specified for that device as defined in this section.

.3 The Contractor shall provide all communication media, connectors, repeaters, bridges, hubs, switches, and routers necessary for the internetwork.

.4 All controllers shall have a communication port for connections with the Operator Workstations using the BACnet Data Link/ Physical layer protocol.

.5 The time clocks in all controllers shall be automatically synchronized daily. An operator change to the time clock in any controller shall be automatically broadcast to all controllers on the network.

2.3 CONTROLLER SOFTWARE

.1 Furnish the following applications software for building and energy management. All software applications shall reside and operate in the system controllers. Editing of applications shall occur at the operator workstation.

.2 System Security

.1 User access shall be secured using individual security passwords and user names.

.2 Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.

.3 User Log On/Log Off attempts shall be recorded.

.3 Scheduling. Provide the capability to schedule each object or group of objects in the system. Each schedule shall consist of the following:

.1 Unit will not be used on a regular schedule. Start and stop will be initiated by users.

.2 Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the appropriate workstations based on time and other conditions.

.3 Remote Communication. The system shall have the ability to dial out in the event of an alarm using BACnet Point-To-Point at a minimum of 56K baud. Receivers shall be BACnet workstations.

.4 Maintenance Management. The system shall monitor equipment status and generate maintenance messages based upon user-designated run-time, starts, and/or calendar date limits.

.5 PID Control. A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, setpoint, and PID gains shall be user-selectable.

.6 Energy Calculations. Provide software to allow instantaneous power (e.g., kW) or flow rates (e.g., L/s (GPM)) to be accumulated and converted to energy usage data. Provide an algorithm that calculates a sliding-window kW demand value.

.7 Anti-Short Cycling. All binary output objects shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.

.8 On/Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and setpoint. The algorithm shall be direct-acting or reverse-acting, and incorporate an adjustable differential.

.9 Run-time Totalization. Provide software to totalize run-times for all binary input objects. A high run-time alarm shall be assigned, if required, by the operator.

2.4 AUXILIARY CONTROL DEVICES

.1 Motorized control dampers, unless otherwise specified elsewhere, shall be as follows:

.1 Sizes:

.1 Blades - maximum 150 mm (6”) wide and 1220 mm (48”) long.

.2 Individual damper sections - maximum 1220 mm (48”) wide and 1524 mm (60”) high.

.3 Multiple sections with stiffening mullions and jack shafts.

.2 Materials:

.1 Frame: - aluminum c/w insulation on 4 sides for insulated units.

.2 Blades: aluminum c/w insulation and thermal breaks for insulated units.

.3 Bearings: oil impregnated sintered bronze or nylon. Provide additional thrust bearings for vertical blades.

.4 Linkage: aluminum and corrosion resistant, zinc and nickel-plated steel.

.5 Seals:

.1 Non-insulated dampers:

.1 EPDM blade gaskets and extruded TPE frame seals.

.2 Insulated dampers:

.1 Silicone blade gaskets and frame seals.

.3 Performance Characteristics:

.1 Air leakage through a 1220 mm x 1220 mm (48" x 48") damper against 1000 Pa (4 in. W.C.) differential static pressure shall not exceed:

.1 Insulated damper:

.1 25 l/s·m^2 (4.9 cfm/ft^2) at -40°C (-40°F).

.2 Non-insulated damper:

.1 52 l/s·m^2 (10.3 cfm/ft^2) at standard air.

.2 Temperature range: 100°C to -40°C (212ºF to -40ºF).

.4 Application:

.1 Insulated:

.1 Outside air, relief air, exhaust air, and isolation dampers installed at penetrations of building envelope

.2 Non-insulated:

.1 Return air, other dampers.

.5 Damper arrangements:

.1 Mixing damper: dampers mixing cold and warm air shall be parallel blade type mounted at right angles to each other with blades opening to mix the air streams.

.2 Face and bypass dampers: opposed blade type.

.3 Other modulating dampers: opposed blade type.

.4 Two-position shutoff dampers: parallel or opposed blade type.

.5 Mounting:

.1 Flanged-to-duct, unless specifically indicated otherwise.

.6 Provide a minimum of one damper actuator per section.

.2 Electric damper/valve actuators.

.1 The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.

.2 Where shown, for power-failure/safety applications, an internal mechanical, spring-return mechanism shall be built into the actuator housing.

.3 All rotary spring-return actuators shall be capable of both clockwise or counter-clockwise spring-return operation. Linear actuators shall spring-return to the retracted position.

.4 Proportional actuators shall accept a 0 to 10 VDC or 2 to 10vdc operating range.

.5 All 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 W for DC applications. Actuators operating on 120 VAC or 230 VAC shall not require more than 11 VA.

.6 All non-spring-return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring-return actuators with more than 7 N·m (60 in-lb) torque capacity shall have a manual crank for this purpose.

.7 Actuators shall be provided with a raceway fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections

.8 Actuators shall be UL Standard 873 Listed and CSA Class 4813 02 Certified as meeting correct safety requirements and recognized industry standards.

.9 Actuators shall be designed for a minimum of 60,000 full-stroke cycles at the actuator's rated torque.

.3 Control valves.

.1 Control valves shall be two-way or three-way type for two-position or modulating service as shown.

.2 Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:

.3 Water Valves:

.1 Two-way: 150% of total system (pump) head.

.2 Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.

.4 Water Valves:

.1 Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.

.2 Sizing Criteria:

.1 Two-position service: Line size.

.2 Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 35kPa (5 psi), whichever is greater

.3 Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 35 kPa (5 psi) maximum.

.4 Valves ½" through 2" shall be bronze body or cast brass ANSI Class 250, spring-loaded, Teflon packing, quick opening for two-position service. Two-way valves to have replaceable composition disc, or stainless steel ball.

.5 2½" valves and larger shall be cast iron ANSI Class 125 with guided plug and Teflon packing.

.3 Water valves shall fail normally open or closed as scheduled on plans, or as follows:

.1 Water zone valves - normally open {preferred}.

.2 Heating coils in air handlers - normally open

.3 Chilled water control valves - normally closed.

.4 Other applications - as scheduled or as required by sequences of operation.

.4 Binary Temperature Devices

.1 Low-voltage space thermostat shall be 24 V, bimetal-operated, with either adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

.2 Line-voltage space thermostat shall be bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, UL listed for electrical rating, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

.3 Low-limit thermostats. Low-limit thermostats shall be vapor pressure type with an element 6 m (20 ft) minimum length. Element shall respond to the lowest temperature sensed by any 30 cm (1 ft) section. The low-limit thermostat shall be manual reset only and be supplied as DPST.

.5 Temperature sensors.

.1 Temperature sensors shall be thermistors.

.2 Duct sensors shall be rigid or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 feet) in length.

.3 Immersion sensors shall be provided with a separable brass well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.

.4 Space sensors shall be equipped with the following:

.1 programmable buttons for setpoint adjustment and override

.2 3-value, 96-segment LCD display

.3 Communication port connected to entire network

.4 Provide matched temperature sensors for differential temperature measurement.

.6 Humidity sensors.

.1 Duct and room sensors shall have a sensing range of 20% to 80%.

.2 Duct sensors shall be provided with a sampling chamber.

.3 Outdoor air humidity sensors shall have a sensing range of 20% to 95% RH. They shall be suitable for ambient conditions of -40°C to 75°C (-40°F to 170°F).

.4 Humidity sensor's drift shall not exceed 3% of full scale per year.

.7 Flow switches.

.1 Flow-proving switches shall be either paddle or differential pressure type, as shown.

.2 Paddle type switches (water service only) shall be UL Listed, SPDT snap-acting with pilot duty rating (125 VA minimum). Adjustable sensitivity with NEMA 1 enclosure unless otherwise specified.

.3 Differential pressure type switches (air or water service) shall be UL Listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application, or as specified.

.8 Relays.

.1 Control relays shall be UL Listed plug-in type with dust cover. Contact rating, configuration, and coil voltage suitable for application

.2 Time delay relays shall be UL Listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable ±200% (minimum) from setpoint shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.

.9 Override timers.

.1 Override timers shall be spring-wound line voltage UL Listed, contact rating and configuration as required by application. Provide 0-to-6-hour calibrated dial unless otherwise specified; suitable for flush mounting on control panel face, located on local control panels or where shown.

.10 Current transmitters

.1 AC current transmitters shall be self-powered combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 0 – 5vdc two-wire output. Unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A full scale, internal zero and span adjustment, and ±1% full scale accuracy at 500 ohm maximum burden

.2 Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.

.3 Unit shall be split-core type for clamp-on installation.

.11 Current transformers

.1 AC current transformers shall be UL/CSA recognized and completely encased (except for terminals) in approved plastic material.

.2 Transformers shall be available in various current ratios and shall be selected for ±1% accuracy at 5 A full scale output.

.3 Transformers shall be split-core type for installation on new or existing wiring,

.12 Voltage transmitters

.1 AC voltage transmitters shall be self-powered single loop (two-wire) type, 4 to 20 mA output with zero and span adjustment.

.2 Ranges shall include 100 to 130 VAC, 200 to 250 VAC, 250 to 330 VAC, and 400 to 600 VAC full-scale, adjustable, with ±1% full-scale accuracy with 500 ohm maximum burden.

.3 Transmitters shall be UL/CSA recognized at 600 VAC rating and meet or exceed ANSI/ISA S50.1 requirements.

.13 Voltage transformers.

.1 AC voltage transformers shall be UL/CSA recognized, 600 VAC rated, complete with built-in fuse protection.

.2 Transformers shall be suitable for ambient temperatures of 4 to 55°C (40 to 130°F) and shall provide ±0.5% accuracy at 24 VAC and a 5 VA load.

.3 Windings (except for terminals) shall be completely enclosed with metal or plastic material.

.14 Power monitors.

.1 Power monitors shall be three-phase type furnished with three-phase disconnect/shorting switch assembly, UL Listed voltage transformers and UL Listed split-core current transformers

.2 Shall provide a selectable rate pulse output for kWh reading and a 1 – 5vdc or 4 to 20 mA output for kW reading. Shall operate with 5 A current inputs with a maximum error of ±2% at 1.0 power factor or ±2.5% at 0.5 power factor.

.15 Current switches

.1 Current-operated switches shall be self-powered, solid-state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

.16 Pressure transducers

.1 Transducer shall have linear output signal. Zero and span shall be field-adjustable.

.2 Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage

.3 Water pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Transducer shall be complete with 1 - 5vdc or 4 to 20 mA output, required mounting brackets, and block and bleed valves.

.4 Water differential pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall be complete with 1 – 5vdc or 4 to 20 mA output, required mounting brackets, and five-valve manifold.

.17 Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application, or as shown.

.18 Pressure-Electric (PE) Switches

.1 Shall be metal or neoprene diaphragm actuated, operating pressure rated 0–175 kPa (0–25 psig), with calibrated scale setpoint range of 14–125 kPa (2–18 psig) minimum, UL listed

.2 Provide one- or two-stage switch action SPDT, DPST, or DPDT, as required by application.

.3 Shall be open type (panel-mounted) or enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified

.4 Shall have a permanent indicating gauge on each pneumatic signal line to PE switches.

.19 Electro-pneumatic (E/P) transducers

.1 Electronic/pneumatic transducer shall provide a proportional 20 to 100 kPa (3 to 15 psig) output signal from a 0 to 10 VDC analog control input.

.20 Local control panels

.1 All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door), key-lock latch, removable sub-panels. A single key shall be common to all field panels and sub-panels

.2 Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL Listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings

.3 Provide 120v receptacle at each local panel location.

2.5 ELECTRICAL AND WIRING

.1 Provide all conduit, wire, relays, connections and other devices required for control circuit wiring necessary for the systems specified in this Division and as required to make a complete, fully functioning control system.

.2 Installation to be in accordance with the requirements of Division 26.

.3 As a minimum, provide conduit for the following systems. Minimum conduit size to be 19mm:

.1 BAS transmission wiring.

.2 All other control wiring connected to an electronic control system including sensor and control wiring associated with DDC panels, etc. which are connected to the BAS system or are capable of connection at some future date.

.4 Where wiring is associated with a life safety system, including but not limited to smoke venting or pressurization systems, wiring shall be listed as having a minimum 2-hr fire rating. Clearly indicated on shop drawings extent of wiring that is to be rated.

2.6 VARIABLE FREQUENCY DRIVES

.1 Variable speed drive package shall consist of a logic control panel and adjustable frequency motor drive in a NEMA 1 enclosure.

.2 Logic control panel: micro processor based programmable controller using EPROM software and input signals from field installed controls. Controller shall contain LCD display for multiple faults, system diagnostics, and operator interface.

.3 General:

.1 Variable torque AC drive.

.2 Adjustable frequency controller.

.3 Capable of driving the standard AC induction motor specified elsewhere.

.4 The adjustable frequency drive shall convert three phase, 60 Hz utility power to an adjustable frequency output for speed control from 0 - 100% of base speed.

.5 The drive must be modifiable to accept standard input voltages accurately.

.6 The adjustable frequency control shall be designed specifically for variable speed fan and pump applications.

.7 The drive, including all factory installed options shall be Underwriters Laboratories and CSA listed.

.4 Basic design:

.1 Micro processor based phase width modulation, design employing IGBT technology to convert three phase AC to a fixed DC voltage.

.2 A constant speed displacement power factor of 0.95 shall be maintained at all speeds and rated loads.

.3 Insulated grade bipolar transistors in the invertor section converts a fixed DC voltage to a three phase adjustable frequency output.

.4 Drive output shall employ a high carrier frequency to ensure quiet motor operation.

.5 The operator's control panel shall consist of soft touch membrane keypad switches, a four-line, 68-chractrer digit backlit LCD display and three multi-colour indicator LEDs.

.6 The control panel shall include the following keypad switches:

.1 Hand/Start “+/-“

.2 Off/Stop Auto/Start

.3 Reset

.4 Various programming keys

.7 Drive status indicators on the control panel include multi-point status and diagnostics.

.8 Adjustments accessible by means of keypad switches:

.1 Acceleration/deceleration time: Independently adjustable to 3600 seconds to/from base speed.

.2 Minimum speed: from minimum speed setting to 0 Hz.

.3 Maximum speed: from maximum speed setting to 120 Hz.

.4 Overload: Adjustable for any percentage of rated current up to 110% to protect motor from excess current at low speeds.

.5 Individual selectable resettable fault control: Automatic functioning of the fault counter reset can be allowed or denied for ground fault, over voltage, under voltage, over current, phase loss, overload, over temperature, external fault, and motor open fault.

.6 Auto rest time: Calibration available from 0 to 600 seconds to prevent too short a reset time from fault occurrence.

.7 Stepover frequency (2 ranges): Adjustable from 0 to 100% speed to allow for critical frequency avoidance.

.9 Features: In addition to start/stop and variable speed shall be:

.1 O-10 VDC follower capacity

.2 Constant torque start

.3 Current limit protection

.4 Independently adjustable acceleration/deceleration

.5 Automatic restart

.6 Over/under voltage protection

.7 DC link reactors

.8 Input and output filters to eliminate noise

.9 EMI/RFI filters

.10 Over temperature and ground fault protection

.11 Minimum 650 V rating

.12 96% efficiency

.13 Input door-interlocked disconnect switch.

.14 Broken belt/loss-of-load protection

.10 Quality Assurance:

.1 To improve quality and eliminate premature failures, all drives shall be pre-tested and cycled with a motor at an elevated ambient temperature.

.11 Start-Up Assistance:

.1 The manufacturer shall provide start-up assistance in the form of a factory trained service technician. When factory authorized start-up is performed, the warranty shall be extended to 24 months from date of Substantial Completion acceptance.

2.7 FLOW MEASURING STATIONS

.1 Duct Mounted Type:

.1 Provide where indicated in the Contract Documents, airflow traverse probes of the insertion type, capable of continuously measuring air volume in the duct served.

.2 Probes shall utilize multiple total and suction pressure measurement points, located along the length of the probe surface in accordance with ASHRAE recommendations for duct traversing.

.3 The probes shall provide measurement accuracy within ± 2% of actual velocity when used with the appropriate conversion formula.

.4 Probes shall be of cylindrical cross section and shall indicate no more than a ± 3% percent deviation from the centerline velocity at a yaw angles up to 30 degrees.

.5 Probes shall be constructed of extruded aluminum, unless dictated otherwise by service requirements. Probes over sixteen inches long shall be supported on the insertion end.

.6 Probe quantities for each location shall be sufficient to meet ASHRAE recommendations.

.7 The pressure drop created by the traverse probes shall not be greater ten percent of the velocity pressure at the maximum design flow.

.8 The probes shall not amplify sound levels in the duct. The manufacturer shall provide submittal data indicating the developed differential pressure and pressure loss at the minimum and maximum design air flows for each duct location.

Part 3 Execution

3.1 EXAMINATION

.1 The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started

.2 The Contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started

.3 The Contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate — or if any discrepancies occur between the plans and the Contractor's work, and the plans and the work of others — the Contractor shall report these discrepancies to the Engineer and shall obtain written instructions for any changes necessary to accommodate the Contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the Contractor to report such discrepancies shall be made by — and at the expense of — this Contractor.

3.2 PROTECTION

.1 The Contractor shall protect all work and material from damage by its work or employees, and shall be liable for all damage thus caused

.2 The Contractor shall be responsible for its work and equipment until finally inspected, tested, and accepted. The Contractor shall protect any material that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects

3.3 COORDINATION

.1 Site

.1 Where the mechanical work will be installed in close proximity to, or will interfere with work of other trades, the Contractor shall assist in working out space conditions to make a satisfactory adjustment. If the Contractor installs its work before coordinating with other trades, so as to cause any interference with work of other trades, the Contractor shall make the necessary changes in its work to correct the condition without extra charge

.2 Coordinate and schedule work with all other work in the same area, or with work which is dependent upon other work, to facilitate mutual progress.

.2 Submittals. Refer to the "Submittals" Article in Part 1 of this specification for requirements

.3 Test and Balance

.1 The Contractor shall furnish all tools necessary to interface to the control system for test and balance purposes

.2 The Contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours

.3 In addition, the Contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.

.4 The tools used during the test and balance process will be returned at the completion of the testing and balancing

.4 Life Safety

.1 Duct smoke detectors required for air handler shutdown are supplied and installed by Electrical Contractor. The Electrical Contractor shall interlock smoke detectors to air handlers for shutdown as described "Sequences of Operation".

.2 Smoke dampers and actuators required for duct smoke isolation are provided under Division 23

.3 Smoke dampers and actuators required for fire rated walls are provided under Division 23. Control of these dampers shall be by Electrical.

.5 Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the Contractor as follows:

.1 All communication media and equipment shall be provided as specified in Part 2: "Communication" of this specification.

.2 Each supplier of controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.

.6 The Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this Section and those provided under other sections or divisions of this specification.

3.4 GENERAL WORKMANSHIP

.1 Install equipment in accordance with manufacturer's recommendations and as specified.

.2 Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

.3 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment

.4 Install all equipment in readily accessible locations and meet the requirements for service access as defined in the Canadian Electrical Code.

.5 All wiring shall be verified for its integrity to ensure continuity and freedom from shorts and grounds

.6 All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.5 FIELD QUALITY CONTROL

.1 All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this specification

.2 Contractor shall continually monitor the field installation for code compliance and quality of workmanship

.3 Contractor shall have work inspected by local and/or state/provincial authorities having jurisdiction over the work

3.6 WIRING

.1 All control and interlock wiring shall comply with national and local electrical codes and Division 26 of this specification. Where the requirements of this section differ with those in Division 16, the requirements of this section shall take precedence

.2 All line voltage wiring shall be ULC Listed in approved raceway per CEC and Division 26 requirement

.3 All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.

.4 All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals

.5 Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the Contractor shall provide step-down transformers.

.6 All wiring shall be installed as continuous lengths, with no splices permitted between termination points/objects

.7 Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations

.8 Size of raceway and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendation and CEC requirements, except as specified elsewhere.

.9 Include one pull string in each raceway 2.5 cm (1") or larger

.10 Use coded conductors throughout with different colored conductors

.11 Control and status relays are to be located in designated enclosures only.

.12 Conceal all raceways including conduit, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15cm (6") from high-temperature equipment (e.g., steam pipes or flues).

.13 Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

.14 Adhere to Division 26 requirements where raceway crosses building expansion joints.

.15 Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.

.16 The Contractor shall terminate all control and/or interlock wiring, and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site

.17 Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal raceway less than ½ " electrical trade size shall not be used. In areas exposed to moisture — including chiller and boiler rooms — liquid-tight, flexible metal raceways shall be used.

.18 Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (per code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed

3.7 COMMUNICATION WIRING

.1 All cabling shall be installed in a neat and professional manner. Follow manufacturer's installation recommendations for all communication cabling.

.2 Do not install communication wiring in raceway and enclosures containing high voltage wiring (120V and greater).

.3 Maximum pulling, tension, and bend radius for cable installation as specified by the cable manufacturer shall not be exceeded during installation.

.4 Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

.5 When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to the manufacturer's instructions

.6 All runs of communication wiring shall be unspliced length when that length is commercially available.

.7 All communication wiring shall be labelled to indicate origination and destination data.

.8 Grounding of coaxial cable shall be in accordance with CEC regulations Article on Communications Circuits, Cable and Protector Grounding

3.8 FIBRE OPTIC CABLE SYSTEM

.1 Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.

3.9 INSTALLATION OF SENSORS

.1 Install all sensors in accordance with the manufacturer's recommendations.

.2 Mount sensors rigidly and adequately for the environment within which the sensor operates

.3 Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing

.4 All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings

.5 Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across duct. Each bend shall be supported with a capillary clip

.6 Low limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m of sensing element for each 1 m^2 (1 ft of sensing element for each 1 ft^2) of coil area

.7 All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

.8 Install outdoor air temperature sensors on north wall complete with sun shield at designated location.

.9 Differential air static pressure

.1 Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable), or to the location of the duct high-pressure tap and leave open to the plenum.

.2 Return Duct Static Pressure: Pipe the low-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor

.10 The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer

.11 All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment

.12 All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

3.10 FLOW SWITCH INSTALLATION

.1 Use correct paddle for pipe diameter.

.2 Adjust flow switch in accordance with manufacturer's instructions

3.11 ACTUATORS

.1 Mount and link control damper actuators per manufacturer's instructions.

.2 To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage

.3 Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

.4 Provide all mounting hardware and linkages for actuator installation.

.5 Electric/Electronic

.1 Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations

.2 Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

.1 The total damper area operated by an actuator shall not exceed 80% of the manufacturer's maximum area rating. Provide at least one actuator for each damper section. Each damper actuator shall not power more than 2 m² (20 ft²) of damper.

.2 Use line shafting or shaft couplings (jackshafting) in lieu of blade-to-blade linkages or shaft coupling when driving axially aligned damper sections.

3.12 IDENTIFICATION OF HARDWARE AND WIRING

.1 Following existing wiring systems and standards already on site where applicable. Where no standard exists, submit sample to Engineer and Owner for approval prior to installation.

.2 All wiring and cabling, including that within factory-fabricated panels, shall be labelled at each end within 5 cm (2") of termination with the DDC address or termination number.

.3 Permanently label or code each point/object of field terminal strips to show the instrument or item served.

.4 Identify control panels with minimum 1 cm (½") letters on laminated plastic nameplates.

.5 Identify all other control components with permanent labels. All plug-in components shall be labelled such that removal of the component does not remove the label.

.6 Identify room sensors relating to terminal box or valves with nameplates.

.7 Manufacturers' nameplates

.8 Identifiers shall match record documents

3.13 CONTROLLERS

.1 Provide a separate controller for each AHU or other HVAC system, unless otherwise approved.

.2 Building Controllers and Advanced Application Controllers shall be selected to provide a minimum of 15% spare I/O point/object capacity for each point/object type found at each location. If input /objects are not universal, 15% of each type is required. If outputs are not universal, 15% of each type is required. A minimum of one spare is required for each type of point/object used.

.1 Future use of spare capacity shall require providing the field device, field wiring, point/object database definition, and custom software. No additional controller boards or point/object modules shall be required to implement use of these spare points

3.14 CONTROL SYSTEM CHECKOUT AND TESTING

.1 Start-up Testing: All testing listed in this article shall be performed by the Contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the Owner's Representative is notified of the system demonstration.

.1 The Contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification

.2 Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight

.3 Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures per manufacturers' recommendations

.4 Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct

.5 Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The Contractor shall check all control valves and automatic dampers to ensure proper action and closure. The Contractor shall make any necessary adjustments to valve stem and damper blade travel

.6 Verify that the system operation adheres to the Sequences of Operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum Start/Stop routines.

.2 Alarms and Interlocks

.1 Check each alarm separately by including an appropriate signal at a value that will trip the alarm

.2 Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.

.3 Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action

3.15 COMMISSIONING

.1 General:

.1 The controls contractor under this Division will be required to participate in commissioning activities as required to demonstrate compliance with the specification and confirm that the design intent has been met.

3.16 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

.1 Demonstration

.1 Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed its own tests

.2 The tests described in this section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, startup, and debugging process and as specified in the “Control System Checkout and Testing” Article in Part 3 of this specification. The Engineer will be present to observe and review these tests. The Engineer shall be notified at least 10 days in advance of the start of the testing procedures.

.3 The demonstration process shall follow that approved in Part 1: “Submittals.” The approved checklists and forms shall be completed for all systems as part of the demonstration

.4 The Contractor shall provide at least two persons equipped with two-way communication, and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point/object and system. Any test equipment required to prove the proper operation shall be provided by and operated by the Contractor.

.5 As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.

.6 Demonstrate compliance with Part 1: “System Performance

.7 Demonstrate compliance with Sequences of Operation through all modes of operation

.8 Demonstrate complete operation of Operator Workstation

.9 Additionally, the following items shall be demonstrated:

.1 DDC Loop Response. The Contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in setpoint, which represents a

change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the setpoint, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.

.2 Demand limiting. The Contractor shall supply a trend data output showing the action of the demand-limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting setpoint, and the status of shed-able equipment outputs.

.3 Optimum Start/Stop. The Contractor shall supply a trend data output showing the capability of the algorithm. The hour-by-hour trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas

.4 Interface to the building fire alarm system

.5 Operational logs for each system that indicate all setpoints, operating points, valve positions, mode, and equipment status shall be submitted to the Architect/Engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.

.6 Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

.10 Acceptance

.1 All tests described in this specification shall have been performed to the satisfaction of both the Engineer and Owner prior to the acceptance of the control system as meeting the requirements of Completion. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Engineer. Such tests shall then be performed as part of the warranty.

.2 The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1: “Submittals.

3.17 CLEANING

.1 The Contractor shall clean up all debris resulting from its activities daily. The Contractor shall remove all cartons, containers, crates, etc., under its control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

.2 At the completion of work in any area, the Contractor shall clean all of its work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

.3 At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to

match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent area.

3.18 TRAINING FOR DDC SYSTEM

.1 General

.1 Provide a minimum of two onsite training class, 4 hours in length each (4 hrs total), during the construction period for personnel designated by the owner.

.2 Train the designated staff of Owner's Representative and Owner to enable Day-to-day Operators to:

.1 Proficiently operate the system.

.2 Understand control system architecture and configuration.

.3 Understand DDC system components.

.4 Understand system operation, including DDC system control and optimizing routines (algorithms).

.5 Operate the workstation and peripherals.

.6 Log on and off the system.

.7 Access graphics, point/object reports, and logs.

.8 Adjust and change system setpoints, time schedules, and holiday schedules.

.9 Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.

.10 Understand system drawings, and Operation and Maintenance manual.

.11 Understand the job layout and location of control components.

.12 Access data from DDC controllers and ASC.

.13 Operate portable operator's terminals.

.3 Provide course outline and materials as per "Submittals" Article in Part 1 of this specification. The instructor(s) shall provide one copy of training material per student.

3.19 SEQUENCES OF OPERATION

.1 Refer to Section 23 09 93.

END OF SECTION

PART 1 General

1.1 SUMMARY

.1 Section includes:

.1 Sequence of operations for DDC (direct digital control) systems for HVAC

1.2 GENERAL

.1 The following sequences shall be controlled through the DDC system, unless otherwise approved.

.2 Provide all points required to execute the sequences specified, operate the equipment safely, provide protection and alarms when failures occur, provide good environmental conditions, indicate system performance, assist problem diagnosis, and provide good energy management.

.3 Provide alarms with logic, auto adjustment, automatic seasonal override and time delays as required, to eliminate false alarms.

.4 PID control available for all control loops, and implemented where appropriate, unless it can be demonstrated that PI control will provide stable and satisfactory control for the specific application.

.5 The Supply and Exhaust AHUs are to work in conjunction with each other. They are to be started manually by occupants when range is in use. Provide LCD control panel in firing range that permits occupant to:

.1 Start and stop the AHU system

.2 Adjust air flow with in a predetermined range from 50 fpm to 80 fpm of air velocity with in the firing range. TAB contractor to determine air flows (VSD speeds) corresponding to air velocities. User setting of air flow above 50 fpm minute shall have a maximum rung time of 1 hour after which, velocity shall automatically reset back to 50 fpm. Unit shall always initially start at 50 fpm air velocity (i.e. reset velocity to 50 fpm after each use).

.3 Adjust space temperature set points within +/-3 C.

.4 View air flow status and alarms.

1.3 ALARMS

.1 Selectable as to local (at the problem), panel (at the control panel) remote (elsewhere on site), off site (contact monitored at off site location) or any combination of these. "Local" is required only when the equipment is remote from the panel, or specifically indicated.

.2 Capable of individually being disabled.

.3 Silence audible easily.

.4 Audible alarm of subsequent alarms.

.5 Annunciation where effective.

.6 Audible to be distinct from fire alarm and other alarms.

.7 Provide alarming as follows:

.1 Analog inputs: Provide user adjustable alarm limits above and below setpoint. Alarm when setpoint is out of range.

.2 Digital inputs: Provide alarming of all digital inputs when current state is opposite to desired state. Desired state for alarming shall be user selectable.

.3 Alarming is to be provided for all seasonal and scheduled states (i.e. different alarm setpoints for winter/summer modes, day/night, etc.).

.4 Alarming to be complete with time delays or sliding scales where appropriate and as directed by Engineer.

.8 Non-Critical Alarms

.1 Similar to critical, but different visual signal without audible.

1.4 SYSTEM SEQUENCES

.1 The following sequences outline the system requirements. Also refer to mechanical equipment specifications and schedules.

.2 Provide all controls required for complete working systems including features specified. Included devices and points as required to allow sequence of operation to be achieved as specified, even if not explicitly included in points list.

.3 Ensure all controls are compatible, including those provided by others. Show the detailed interfaces on the control shop drawings (i.e. packaged equipment wiring diagrams).

.4 All setpoints shown are suggested initial values only, to be adjusted as required during commissioning.

.5 Abbreviations:

AFMS	- airflow measuring station	MA	- mixed air
AHU	- air handling unit	MAT	- mixed air temperature
AI	- analogue in	MRT	- manual reset timer
AO	- analogue out	OA	- outdoor air
CCV	- cooling control valve	OAT	- OA temperature
CSR*	- current sensing relay	OWS	- operator workstation (system terminal)
DDC	- direct digital control	RA	- return air
DI	- digital in	RAT	- return air temperature
DO	- digital out	RF	- return fan
DX	- direct expansion	RH	- relative humidity
EA	- exhaust air	SA	- supply air
EAT	- exhaust air temperature	SAT	- SA temperature
EF	- exhaust fan	SF	- supply fan

HCV	- heating control valve	SP	- static pressure
HGR	- hot glycol return	TD	- time delay
HGS	- hot glycol supply	VAV	- variable air volume
VFD	- variable frequency drive	HRP	- heat recovery pipe

* Or CT (current transducer) as appropriate to application.

.6 All sequences shall provide for safe and effective start and stop routines, such as:

.1 TD on fan stops with electric coils

.2 ramp starts

.3 dampers on make-up air units open wide before fan start for fans without VFD.

.4 interlocks

.7 Provide airflow proving switches on supply systems to enable normal control sequences.

.8 Monitor all motor driven equipment for status using current sensing relays, unless proof of actual operating status is available by other means (i.e. output from VFD).

.9 Design all systems required to activate on fire alarm for failsafe operation, such that loss of signal from the fire alarm interconnection shall initiate sequence.

.10 Accuracy to be ± 0.5ºC (1ºF) for all temperature controls. Control space temperature at ± 0.1ºC (2ºF), and space humidity ± 5% RH, unless otherwise specified.

.11 Temperature reset sequences shall be designed such that they stable and minimize overshoot and hunting. Loops shall be self-tuning and provide the operator with the ability to fine tune their operation.

.12 Sequences shall utilize common outside air sensor and common outside air humidity sensor as required to achieve control functions, unless otherwise specified.

.13 Monitor position of shut-off/isolation dampers using end switch and report to the BMS.

1.5 DDC SOFTWARE APPLICATION – GENERAL

.1 Implement following control strategies and techniques within DDC software developed for all systems controlled by DDC controllers. Control setpoints shall be as described in individual system sequences of operation specified in this section. They shall be obtained and/or adjusted utilizing operator's terminal specified in clause "Direct Digital Control System".

.2 Mixed air temperature control – OA and RA dampers shall modulate to maintain mixed air temperature. Mixed air temperature control shall interact with minimum OA control and system shall revert to minimum OA on signal from dry bulb, enthalpy or other economizer control as specified in individual sequences of operation in this section.

.3 Minimum OA control (constant volume systems w/o airflow measuring) – calculate percent of OA actually provided by utilizing OA, return air and mixed air temperatures. Override mixed air control sequence if necessary to ensure minimum OA is maintained.

If SA temperature falls more than 2ºC (4ºF) below setpoint minimum OA shall be reduced to provided largest minimum OA possible while SA temperature is maintained.

.4 Minimum OA control (variable volume systems w/o air flow measuring stations) – calculate actual quantity (L/s) of OA provided by utilizing OA, return air and mixed air temperatures and system total flow (sensed by supply air flow station). Override mixed air control sequence if necessary to ensure minimum OA quantity is maintained. If SA temperature falls more than 2ºC (4ºF) below setpoint minimum OA quantity shall be reduced to provide largest OA quantity possible while discharge air temperature is maintained.

.5 Minimum OA control (variable air volume systems with airflow measuring stations and relief direct from space) – calculate volume of outside air based on measured supply air volume minus measured return air volume.

.6 Minimum OA control (variable air volume systems with air flow measuring stations and economizer sections) – calculate volume of outside air based on measured supply air volume minus measured relief air volume.

.7 Supply air volume control (variable volume system) – modulate supply fan volume to maintain supply duct static pressure. SA volume control shall interact with SA temperature control.

.8 Return air volume control (variable volume systems) – modulate return fan volume to maintain duct static pressure at the fan discharge.

.9 Relief dampers shall be controlled from space static pressure referenced to outdoors. Where systems are equipped with air flow measuring stations, include provision to select control option of controlling relief damper to provide required outside air flow.

.10 Supply air temperature control (variable volume systems) – modulate, when applicable, OA and return air dampers, heating and cooling equipment in sequence to maintain SA temperature. Where noted in individual sequences of operation in this section, SA temperature setpoint shall be automatically reset.

.11 Where no air flow monitoring station is used the reset shall be based on the percentage output to the SA volume control device (i.e. damper operator variable frequency controller, etc.)

.12 Ramp functions – where control loops are subject to rapid load changes (i.e. supply fan volume control on system start-up, OA damper control on system start-up, mixed air and discharge air temperature control when systems are manually switched to 100% OA mode of operation, etc.). Ramp functions shall be implemented to prevent system overshoot, cycling and nuisance tripping of low limit protection devices.

.1 Where mixed air systems are not present (i.e. 100% OA systems), unit shall have soft start capability – VFD shall increase fan speed as supply air temperature rises in cold weather. Damper position to start low and increase as fan speed increases to avoid freezing and false alarms.

.13 Reset Schedules – Where control loops have reset schedules associated with the, (i.e. hot water supply temperature reset based on OA temperature) high and low temperature

alarm indication shall also be on sliding schedule, e.g. If alarm limits are set at ±2ºC (4ºF) from setpoint, alarm will be generated only if the sensed temperature is above or below present setpoint by 2ºC (4ºF) (i.e. if present, setpoint is 85ºC then alarm limits are 83ºC and 87ºC). Indication available to operator shall include, low end point of reset schedule, high end point of reset schedule, present setpoint, present high and low alarm limits and sensed temperatures.

.14 Alarms shall be inhibited from reporting when the associated HVAC system is normally inactive (either seasonally, or on a time basis), (e.g. supply air temperature outside normal limits when unit is shut down at night).

.15 All pumps and fans that are normally under automatic control via the EMCS shall be provide with "Hand-OFF-Auto" toggle at the OWS graphic, to allow manual control over equipment (override) regardless of time schedule/occupancy status.

.16 Provide 'night purge' cycle for all air handling units to allow building flushing with 100% outside air. Night purge cycle shall be initiated automatically if the following conditions are met (all points user adjustable), subject to time of day override. Provide toggle to allow operator to enable or disable automatic start of night purge cycle:

.1 OA relative humidity

.2 OA temperature

.3 OA temperature minus space ambient temperature

.4 Time of day

.5 Supply air setpoint

1.6 FAN SYSTEM CONTROLS – GENERAL

.1 Following control sequences shall apply to all supply fan systems whether specifically noted in sequence of operation or not.

.2 Provide interlocks to ensure system controls energize and associated return and/or exhaust fans run when supply fan runs.

.3 Provide interlocks to ensure auxiliary equipment such as humidifiers, humidifier valves, outdoor air dampers, relief air dampers, etc., are shut off and/or closed when supply fan is off.

.4 Where steam, hot water or glycol heating coils are utilized, the mixed air temperature controller shall modulate media flow through coil when supply fan is off in order to prevent low temperature (due to damper leakage) and overheating conditions within the system plenum and/or ductwork.

.5 Where hot water or glycol heating coils have coil circulation pumps and 3-way valves associated with them, provide interlocks to ensure that circulating pump shall run automatically when OA temperature is below 13ºC (55ºF).

.6 Provide all fan systems that introduce OA with an adjustable low limit control in the discharge air to shut down the fan system and alarm on the DDC when the discharge air temperature drops below 3ºC (37ºF). Locate low limit in manner that shall protect heating and cooling coils, and at same time not be subject to nuisance tripping.

.7 Where relief air dampers are not directly ducted to supply/return fans, provide a back-draft temperature controller to prevent back draft-condition from occurring.

.8 On variable volume systems with supply duct static pressure control of supply fan volume, static pressure sensor shall be located at the end of the longest duct run. Should relocation of static pressure sensor be required to provide proper system control, BMS Contractor shall relocate sensor as directed by Engineer at no additional cost. Provide a second independent static pressure sensor located in supply fan discharge to function as a high limit and override control of the supply fan volume device to prevent over-pressurization of system. Variable volume return and/or exhaust systems with duct static pressure control to be treated in a similar manner with a second independent static pressure sensor located in fan inlet to function as a low limit and override control of the fan volume device to prevent under-pressurization of system.

.9 On 100% OA and EA systems provide end switch on isolation damper to ensure it is fully open prior to starting the fan. End switch shall be independent of damper actuator, and shall prove damper is open, not actuator stroke.

1.7 MECHANICAL COOLING AVAILABILITY

.1 Some sequences may revert back to 'free' cooling when mechanical cooling is not available.

.2 Mechanical cooling is not available when it is called for, a TD of 10 minutes has expired, and the refrigerant suction temperature is over 10ºC (50ºF).

PART 2 Sequence of Operation

2.1 GENERAL

.1 For additional information, refer to manufacturer's descriptions.

2.2 POWER FAILURE

.1 Provide safe automatic re-start following power failure and clearing of fire alarms, except where manual reset is requested by the engineer or safe re-start is impossible. For larger systems include a time delay to limit starts on multiple 'bumps' and to avoid simultaneous re-start with lights, etc.

2.3 WINNIPEG FIRING RANGE SUPPLY AHU:

.1 Equipment:

.1 Supply Air Handling Unit (100% outside air): Custom air handling unit, c/w supply fan, and hydronic heating coil, hydronic cooling coil, glycol heat recovery section, inlet section, filters, and humidification section.

.2 Temperature Sensors:

.1 OA.

.2 Room Air Temperature.

.3 Room Humidity

.4 SAT.

.3 Other Sensors:

.1 Filter differential pressure (each filter section).

.4 Temperature Limits:

.1 Low SAT.

.5 Humidity Limits:

.1 High SA RH.

.2 High Room Humidity

.6 Alarms:

.1 SF failure.

.2 Low SAT.

.3 High filter differential pressure.

.4 Low SAT.

.5 High SA RH.

.7 Control Loops:

.1 Time:

.1 Unit shall run based on manual start/stop with 2 hour run time timer.

.1 Touch screen LCD control panel located in firing range will have start/stop button for user control of unit.

.2 Heating:

.1 Modulate heating glycol control valve to maintain optimized SAT setpoint. Transmit any alarm if supply air temperature varies from setpoint by a user defined amount.

.3 Cooling:

.1 Use free cooling when space temperature conditions and outdoor air temperatures warrant. Under free cooling, mechanical cooling and heating are OFF.

.2 The free cooling program shall apply to cooling cycle only. Free cooling shall only be used if the outdoor air temperature is at least within 3 C below the supply air setpoint. Free cooling shall stop when the supply air temperature setpoint can not be maintained without the addition of mechanical cooling or heating.

.3 Use mechanical cooling when space conditions and outdoor air warrant. Under mechanical cooling, the heating is OFF.

.1 There shall be a mechanical cooling temperature space setpoint of 23 C (or as assigned by operator) in the mechanical cooling season. If the maximum space setpoint exceeds 23 C and the outside air temperature is above the free cooling conditions defined above, the AHU shall start the mechanical cooling system.

.2 Modulate chilled water valve to maintain supply air setpoint at optimal cooling supply air set point, minimum 13 C. Send out alarm if supply air temperature varies from setpoint by user defined amount.

.4 The maximum occupied zone space temperature input shall control cooling. The minimum occupied zone space temperature shall control heating in any cycle.

.4 Heat Recovery:

.1 Interlock operation of supply air AHU with run-around glycol heat recovery system.

.2 Heat recovery system work in both cooling and heating mode and shall be off during free cooling mode.

.1 In cooling mode, enable heat recovery only if exhaust air temp is 3°C higher than ambient temperature.

.5 Fans:

.1 The DDC system shall start supply fan from end switches on supply and intake dampers. The damper endswitch shall be independent of the damper actuator and shall be attached to a damper blade that is not directly driven by the actuator. Dampers must be OPEN before the AHU is allowed to start.

.1 During cold weather, open heating control valve 100% and ramp VSD up slowly as supply air temperature rises.

.2 The supply fan shall use a supply duct static pressure reset strategy.

.3 Once the supply fan is running, modulate the supply fan VSD to satisfy the duct static pressure setpoints using the space as the static pressure reference point. The minimum and maximum supply duct static pressure setpoints must be determined in the field by TAB Contractor.

.1 TAB contractor to determine duct static setpoints for various “feet-per-minute” velocities in the firing range.

.4 Provide LOW and HIGH static alarm for supply duct, and space static. Except for the high static alarms, alarms shall not be enabled until the system pressure has ramped up and stabilized. Disable static pressure alarms when the fans are OFF.

.5 If there is a supply duct static high pressure alarm, generate the alarm and modulate the supply VSD to low speed. If the alarm exists after a user defined time, shut down the supply fan and provide a critical alarm. Fans shall then be restarted manually by operator. Provide a separate duct static high limit at AHU supply discharge (initially set to 750 Pa 3.0” w.c.).

.6 If there is a supply duct low pressure alarm, generate the alarm and modulate the supply VSD to high speed to satisfy the duct static condition.

.7 If low temperature limit alarms trip, stop the AHU fan, return all dampers to fail safe position, open heating control valve to 100% and generate an alarm.

.8 The AHU supply and return fan shall shut down when the building is in a fire alarm condition. Fan shall not run until the fire alarm condition is cleared.

.6 Ventilation:

.1 Occupied – AHU provides continuous ventilation for occupants and pollutant control.

.2 Unoccupied – AHU off.

.7 Humidification:

.1 Modulate steam humidification valve to satisfy space humidification sensor (initially set to 25% minimum). Limit supply duct relative humidity to maximum of 80%.

.8 Interlocks:

.1 AHU controls with motorized dampers.

.2 Exhaust Air Handling Unit shall operate in conjunction with this unit

.8 Energy Management Control Features:

.1 Timed operation.

.2 Glycol run around heat recovery.

.3 "Free" cooling.

2.4 WINNIPEG FIRING RANGE EXHAUST AHU:

.1 Equipment:

.1 Exhaust Air Handling Unit: Custom air handling unit, c/w exhaust fan, and, glycol heat recovery section, inlet section, and filters.

.2 Temperature Sensors:

.1 Exhaust air temperature at unit discharge.

.3 Other Sensors:

.1 Filter differential pressure (each filter section).

.4 Alarms:

.1 EF failure.

.2 High filter differential pressure.

.5 Control Loops:

.1 Time:

.1 Unit shall run based on manual start/stop with 2 hour run time timer.

.1 Touch screen LCD control panel located in firing range will have start/stop button for user control of unit.

.2 Heat Recovery:

.1 Interlock operation of exhaust air AHU with run-around glycol heat recovery system.

.2 Heat recovery system work in both cooling and heating mode and shall be off during free cooling mode.

.3 Fans:

.1 The DDC system shall start exhaust fan from end switches on exhaust damper. The damper endswitch shall be independent of the damper actuator and shall be attached to a damper blade that is not directly driven by the actuator. Dampers must be OPEN before the AHU is allowed to start.

.2 The exhaust fan shall track supply fan VSD speed to maintain negative pressure in room.

.3 Once the exhaust fan is running, modulate the exhaust fan VSD to maintain 10% higher air flow than supply air AHU.

.4 Provide HIGH static alarm for exhaust duct.

.5 Provide High and Low static alarm for space.

.6 If there is an exhaust duct static high pressure alarm, generate the alarm and modulate the supply VSD to low speed. If the alarm exists after a user defined time, shut down the exhaust fan and provide a critical alarm. Fans shall then be restarted manually by operator. Provide a separate duct static high limit at AHU supply discharge (initially set to 750 Pa 3.0" w.c.).

.7 If there is a high space static (i.e room is no longer negative) provide local alarm, audible and visual alarm at control panel and space.

.8 The AHU fan shall shut down when the building is in a fire alarm condition. Fan shall not run until the fire alarm condition is cleared.

.4 Interlocks:

.1 AHU controls with motorized dampers.

.2 Supply Air Handling Unit shall operate in conjunction with this unit

.6 Energy Management Control Features:

.1 Timed operation.

.2 Glycol run around heat recovery.

2.5 ROOM PRESSURE MONITORING

.1 Monitor space static pressure in firing range and in firing range entrance vestibule.

.1 If static pressure is not negative for a sustained period (initially set at 3min), provide visual alarm locally at LCD control panel and at sensor located at entrance to vestibule (on the control room side).

.1 If static pressure remains positive for a longer period of time (initially set at 10 min), then alarm to DDC and increase exhaust VSD temporarily to 25% higher airflow in order to achieve negative pressure.

.2 The sensor located on the control room side shall have visual LED strip on the sides of the sensor for full 180 degree visual indication. The LCD and LEDs will illuminate GREEN when vestibule is shown to have positive pressure in comparison to the firing range and RED when pressure between vestibule and range is negative. The LCD and LEDs shall illuminate blue when range is not in use.

.3 The room pressure sensor shall utilize two stainless steel louvered plates for accurate reading and protection from cleaning, located on the vestibule and firing range side.

.4 The sensor shall only operate when firing range is in use (i.e. when supply and exhaust air handling units are active).

PART 3 Execution

.1 Not used.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASME

.1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII.

.2 ASTM International

.1 ASTM A47/A47M], Standard Specification for Ferritic Malleable Iron Castings.

.2 ASTM A278/A278M, Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).

.3 ASTM A516/A516M, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.

.4 ASTM A536, Standard Specification for Ductile Iron Castings.

.5 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

.3 CSA Group

.1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for expansion tanks, air vents, separators, valves, and strainers and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for hydronic specialties for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and recycling.

Part 2 Products

2.1 AUTOMATIC AIR VENT

.1 Standard float vent: brass body and NPS 1/8 connection and rated at 310 kPa working pressure.

.2 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 860 kPa working pressure.

2.2 AIR SEPARATOR - IN-LINE

.1 Working pressure: 860 kPa.

.2 Size: NPS 1 1/2.

2.3 COMBINATION SEPARATORS/STRAINERS

.1 Steel, tested and stamped in accordance with ASME BPVC, for 860 kPa operating pressure, with galvanized steel integral strainer with 5 mm perforations, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.4 COMBINATION LOW PRESSURE RELIEF AND REDUCING VALVE

.1 Adjustable pressure setting: 206 kPa relief, 55 to 172 kPa reducing.

.2 Low inlet pressure check valve.

.3 Removable strainer.

2.5 PIPE LINE STRAINER

.1 NPS 1/2 to 2: bronze body to ASTM B62, solder end connections, Y pattern.

.2 NPS 2 1/2 to 12: cast steel body to ASTM A278/A278M, Class 30, flanged connections.

.3 NPS 2 to 12: T type with ductile iron body to ASTM A536, grooved ends.

.4 Blowdown connection: NPS 1.

.5 Screen: stainless steel with 1.19 mm perforations.

.6 Working pressure: 860 kPa.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic specialties installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.3 GENERAL

.1 Run drain lines and blow off connections to terminate above nearest drain.

.2 Maintain adequate clearance to permit service and maintenance.

.3 Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.

.4 Check shop drawings for conformance of tappings for ancillaries and for equipment operating weights.

3.4 STRAINERS

.1 Install in horizontal or down flow lines.

.2 Ensure clearance for removal of basket.

.3 Install ahead of each pump.

.4 Install ahead of each automatic control valve larger than NPS 1 and as indicated.

3.5 AIR VENTS

.1 Install at high points of systems.

.2 Install gate valve on automatic air vent inlet. Run discharge to nearest drain.

3.6 PRESSURE SAFETY RELIEF VALVES

.1 Run discharge pipe to terminate above nearest drain.

3.7 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: separate waste materials for recycling

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section includes:

.1 Materials and installation for steel piping, valves and fittings for hydronic systems in building services piping.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME).

.1 ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
.2 ASME B16.3, Malleable Iron Threaded Fittings.
.3 ASME B16.5, Pipe Flanges and Flanged Fittings.
.4 ASME B16.9, Factory-Made Wrought Buttwelding Fittings.
.5 ASME B16.20, Metallic Gaskets for Pipe Flanges: Ring Joint Spiral Wound and Jacketed
.6 ASME B16.21, Nonmetallic Flat Gaskets for Pipe Flanges
.7 ASME B18.2.1, Square and Hex Bolts and Screws (Inch Series).
.8 ASME B18.2.2, Square and Hex Nuts (Inch Series).

.2 American Society for Testing and Materials International, (ASTM).

.1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
.2 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
.3 ASTM A536, Standard Specification for Ductile Iron Castings.
.4 ASTM B61, Standard Specification for Steam or Valve Bronze Castings.
.5 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
.6 ASTM E202, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.

.3 Canadian Standards Association (CSA International).

.1 CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.
.2 CAN/CSA W48, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).

.4 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).

.1 MSS-SP-67, Butterfly Valves.
.2 MSS-SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.
.3 MSS-SP-71, Cast Iron Swing Check Valves Flanged and Threaded Ends.
.4 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.
.5 MSS-SP-85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

.5 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME).

.1 ANSI/ASME B1.20.1, Pipe Threads, General Purpose (Inch).

.2 ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.

.6 American Society for Testing and Materials International, (ASTM).

.1 ASTM A276, Specification for Stainless Steel Bars and Shapes.

.2 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.

.3 ASTM B283, Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).

.4 ASTM B505/B505M, Specification for Copper-Base Alloy Continuous Castings.

.7 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).

.1 MSS-SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions.

.2 MSS-SP-80, Bronze Gate Globe, Angle and Check Valves.

.3 MSS-SP-110, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 MAINTENANCE

.1 Extra Materials.

.1 Provide following spare parts:

.1 Valve seats: one for every ten valves, each size. Minimum one.

.2 Discs: one for every ten valves, each size. Minimum one.

.3 Stem packing: one for every ten valves, each size. Minimum one.

.4 Valve handles: two of each size.

.5 Gaskets for flanges: one for every ten flanges.

1.4 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.

1.5 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

Part 2 Products

2.1 PIPE

.1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:

.1 Hot water heating, glycol piping services:

.1 To NPS 10: Schedule 40.

2.2 PIPE JOINTS

.1 Except as noted below:

.1 NPS2 and under: screwed fittings with PTFE tape or lead-free pipe dope.

.2 NPS2-1/2 and over: welding fittings and flanges.

.2 On glycol service, weld all pipe up to including 50mm, except use threaded connections at equipment and components that require removal for servicing.

.3 Branch connections to radiation/wall fin up to 25mm may be formed on mains using manufactured threaded connection fittings, manufactured by ASTM A181, Grade 1.

.4 Branch connections to 32mm and larger to be using using manufactured welded connection fittings, manufactured by ASTM A181, Grade 1.

.5 Pipe thread: taper.

2.3 FITTINGS

.1 Screwed fittings: malleable iron, to ASME B16.3, Class 150

.2 Pipe flanges and flanged fittings:

.1 Cast iron: to ASME B16.1, Class 125.

.2 Steel: to ASME B16.5, Class 150.

.3 Forged carbon steel flanges. Use 1034 kPa flanges on water system operating up to 682 kPa. Use 2068 kPa flanges on systems operating above 682 kPa.

.4 Plain face for connecting to materials of lesser strength, such as cast iron or bronze.

.5 Raised face when connecting to materials of equal strength. Provide raised face on only one flange of each joint, unless otherwise recommend by manufacturer.

.3 Flange gaskets: to ASME B16.21

.4 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.

.5 Butt-welding fittings: steel, to ASME B16.9.

.6 Unions: malleable iron, to ASTM A47/A47M and ASME B16.3.

.7 Use long radius elbows.

.8 Orifice flanges: slip-on raised face, 2100 kPa.

.9 Dielectric Flanges and Unions:

.1 Provide where pipes of dissimilar metals are joined. Unions to be rated to 150C.

.10 Provide unions or flanges for pipe 50mm and smaller and flanges on piping 64mm and larger.

2.4 VALVES

.1 General:

.1 Application for each valve type indicated is for general information only. Refer to drawings and other specifications sections for additional valve applications.

.2 Except for specialty valves, to be single manufacturer.

.3 All products to have CRN registration numbers.

.4 Connections:

.1 NPS2 and smaller: screwed ends.

.2 NPS2.1/2 and larger: Flanged ends.

.2 Ball valves: to MSS-SP-110:

.1 NPS 2 and under:

.1 Body and cap: cast high tensile bronze to ASTM B62.

.2 Pressure rating: Class125.

.3 Connections:

.1 Screwed ends to ANSI B1.20.1. and with hexagonal shoulders.

.4 Stem: tamperproof ball drive.

.5 Stem packing nut: external to body.

.6 Ball and seat: replaceable chrome-plated brass solid ball and teflon seats.

.7 Stem seal: TFE with external packing nut.

.8 Operator: removable lever handle

.3 Gate valves: to MSS-SP-70 and MSS-SP-82, as applicable

.1 Application: Isolating equipment, control valves, pipelines .

.2 NPS 2 and under, rising stem, solid wedge disc, Class 125

.1 Body: bronze, screwed connections with hexagonal shoulder.

.2 Bonnet: screwed with stem retaining nut.

.3 Packing: PTFE

.4 Operator: non-ferrous handwheel.

.5 Use non-rising stem only where space is constrained, upon approval of the engineer.

.3 NPS 2 1/2 - 8, non rising stem, inside screw, bronze trim, solid wedge disc, Class 125:

.1 Body, bonnet: cast iron to ASTM B209 Class B, bolted bonnet.

.2 Connections: flanged ends to ANSI B16.1.

.3 Disc: solid offset taper wedge, bronze to ASTM B62.

.4 Packing and gaskets: non-asbestos.

.5 Seat rings: renewable bronze to ASTM B62, screwed into body.

.6 Stem: bronze to ASTM B62.

.7 Operator: Handwheel, die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49. Nut of bronze to ASTM B62.

.4 Globe valves: to MSS-SP-80 and MSS-SP-85, as applicable.

.1 Application: Throttling, flow control, emergency bypass:

.2 NPS 2 and under, composition disc, Class 125:

.1 Body: bronze, screwed connections with hexagonal shoulder.

.2 Bonnet: union bonnet.

.3 Packing: PTFE

.4 Disc and seat: renewable rotating, PTFE disc, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.

.5 Operator: non-ferrous handwheel.

.6 Use non-rising stem only where space is constrained, upon approval of the Engineer.

.3 NPS 2 1/2 - 8, outside screw and yoke, rising stem, bronze trim, solid bronze disc, Class 125:

.1 Body: with multiple-bolted bonnet.

.2 Bonnet-yoke gasket: non-asbestos.

.3 Disc: bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.

.4 Seat ring: renewable, regrindable, screwed into body.

.5 Stem: bronze to ASTM B62.

.6 Operator: Handwheel.

.5 Balancing, for Testing, Adjusting and Balancing:

.1 Application: measurement and flow adjustment at equipment, branch and main pipelines.

.1 NPS 2 and under:

.1 Body: bronze with brass ball, carbon filled TFE seat rings, with differential pressure read-out ports across valve seat.

.2 Connections: screwed or sweat

.3 Read-out ports: fitted with check valve, internal insert.

.4 Calibrated nameplate, memory stop feature to permit closing of valve for service without affecting balance setting.

.2 NPS 2 ½ to 3:

.1 Body: cast iron with brass ball, carbon filled TFE seat rings, with differential pressure read-out ports across valve seat.

.2 Connections: flanged

.3 Read-out ports: fitted with check valve, internal insert.

.4 Calibrated nameplate, memory stop feature to permit closing of valve for service without affecting balance setting.

.3 NPS 4 and larger:

.1 Body: cast iron with bronze seat, replaceable bronze disc, EPDM seal insert, with differential pressure read-out ports across valve seat.

.2 Connections: flanged

.3 Read-out ports: fitted with check valve, internal insert.

.4 Calibrated nameplate, memory stop feature to permit closing of valve for service without affecting balance setting.

.6 Drain valves:

.1 Application: to permit draining of equipment and pipelines.

.1 Pipe sizes up to NPS 10:

.1 NPS ¾ ball valve with ¾" male threaded hose connection, cap and chain.

.7 Swing check valves: to MSS-SP-71 and MSS-SP-80, as applicable.

.1 Application: at inlet to pumps, bypass lines.

.1 NPS 2 and under, Y-pattern swing type, bronze disc, Class 125:

.1 Body: bronze, screwed connections with hexagonal shoulder.

.2 Cap: screwed.

.3 Disc: brass to NPS ¾, bronze to NPS 2

.2 NPS 2 ½ and over: Swing check valves, Class 125:

.1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin.

.2 Flanged ends: plain faced with smooth finish.

.1 Up to NPS 16: cast iron to ASTM A126 Class B.

.3 Disc: rotating for extended life..

.1 Up to NPS 6: bronze to ASTM B 62.

.2 NPS 8 and over: bronze-faced cast iron.

.4 Seat: renewable bronze to ASTM B62 screwed into body.

.5 Hinge pin, bushings: replaceable brass.

.8 Multi-purpose valves (combination check/balancing/isolation valve):

.1 Application: on discharge side of pumps

.2 NPS 2 and under, straight pattern:

.1 Body: bronze, screwed connections.

2.5 STAINLESS-STEEL BELLOW, FLEXIBLE CONNECTORS

.1 Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.

.2 End Connections: Threaded or flanged to match equipment connected.

.3 Performance: Capable of 20-mm (3/4-inch) misalignment.

.4 CWP Rating: 1035 kPa (150 psig).

.5 Maximum Operating Temperature: 121 deg C (250 deg F).

Part 3 Execution

3.1 PIPING INSTALLATION

.1 Install piping approximately as shown, with all lines being carried parallel to building walls and as close to the structure as possible.

.2 Conceal all piping except where otherwise approved. Exposed piping must be carefully in a neat and tidy manner and must meet the Architect's requirements with respect to visual appearance.

.3 Grade water and glycol lines up in direction of flow to aid in venting.

.4 Cold spring piping where change in directions are shown for expansion compensation.

3.2 VALVES

.1 Install valves of type suitable to the application at the following locations and as indicated on the drawings:

- .1 Isolation valves:
  - .1 Inlet and outlet to each piece of equipment.
  - .2 Ahead of control valves.
  - .3 Provide isolation valve on discharge of balancing valves.
  - .4 Base of risers.
  - .5 On each branch line adjacent to main, where branch serves more that one piece of equipment.
  - .6 Use ball valves for service on water and glycol service.
- .2 Drain valves:
  - .1 Low points of piping systems.
  - .2 At each piece of equipment.
- .3 Check valves:
  - .1 Discharge of pumps.
- .4 Balancing valves:
  - .1 Discharge of pumps.
  - .2 Outlet piping from coils, radiation, unit and force flow heaters.

.2 Install rising stem valves in upright position with stem above horizontal.

.3 Provide 3 valve by-passes at the following locations:

- .1 Pressure reducing valves.
- .2 Around coil control valves where design entering air temperature is less than 5C.

.4 Provide union or flange downstream of isolation valves to permit removal of equipment.

3.3 WELDING

.1 Make pipe to pipe welded joints with open, secure butt welds, reinforced by metal in excess of the net throat dimensions by at least 1.5 (1/16") built up to give a gradual increase in thickness from edge to centre. Clean all rust, paint, oil, grease or foreign matter from all welding faces and adjoining pipe surfaces for a depth of at least 12 (½") from the edge of welding groove. Maintain a surface clearance of 1.5 (1/16"). Carefully align piping using proper clearances and tacking before welding. Leave welded surfaces clean.

.2 Welding must be performed by welders with proper certificates. All field welding must be in accordance with the procedures of CSA-W55.2-1957 and CSA-W117.2-1974 and the current edition of ASME Code for Power Piping. Do not caulk or pean welds. Perform all welding above 4.4ºC (40ºF) if necessary preheat to at least 21ºC (70ºF).

3.4 FLEX CONNECTIONS

.1 Install flexible connections at connections to base-mounted pumps. Flexible connections not required on inline pumps unless recommended by pump manufacturer.

.2 Install to absorb vibration and misalignment.

.3 Insulate same as pipe.

3.5 CIRCUIT BALANCING VALVES

.1 Install valve of size appropriate to design flow expected through valve. Coordinate with TAB contractor and confirm sizing with valve manufacturer.

.2 Provide straight pipe lengths upstream and downstream of valve to manufacturer's recommendations. Relocate valve if necessary to accommodate these requirements, subject to approval of the Engineer.

3.6 CLEANING, FLUSHING AND START-UP

.1 In accordance with Section – 'Cleaning and Start-Up of Mechanical Piping Systems'.

3.7 TESTING

.1 Test system in accordance with Section 23 05 02 Installation of Pipework.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Sheet Metal and Air Conditioning National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for dampers for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and recycling.

Part 2 Products

2.1 GENERAL

.1 Manufacture to SMACNA standards.

2.2 SPLITTER DAMPERS

.1 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.

.2 Double thickness construction.

.3 Control rod with locking device and position indicator.

.4 Rod configuration to prevent end from entering duct.

.5 Pivot: piano hinge.

.6 Folded leading edge.

2.3 SINGLE BLADE DAMPERS

.1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.

.2 Size and configuration to recommendations of SMACNA.

.3 Locking quadrant with shaft extension to accommodate insulation thickness.

.4 Inside and outside nylon end bearings.

.5 Channel frame of same material as adjacent duct, complete with angle stop.

2.4 MULTI-BLADED DAMPERS

.1 Factory manufactured of material compatible with duct.

.2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.

.3 Maximum blade height: 100 mm.

.4 Bearings: pin in bronze bushings.

.5 Linkage: shaft extension with locking quadrant.

.6 Channel frame of same material as adjacent duct, complete with angle stop.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for damper installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

.1 Install where indicated.

.2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.

.4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.

.5 Dampers: vibration free.

.6 Ensure damper operators are observable and accessible.

.7 Corrections and adjustments conducted by Departmental Representative.

.8 All perforated supply air grilles in firing range plenum wall to be equipped with opposed blade dampers with hex key operator, accessible from front of grille.

.9 All exhaust and return inlets in firing range to be equipped with opposed blade dampers with locking quadrant lever.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: separate waste materials for recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 National Fire Protection Association (NFPA)

.1 NFPA 90A-12, Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S112, Standard Test Method of Fire Test of Fire Damper Assemblies.

.2 CAN/ULC-S112.2, Standard Method of Fire Test of Ceiling Fire Stop Flap Assemblies.

.3 ULC-S505, Standard for Fusible Links for Fire Protection Service.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for fire and smoke dampers and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Indicate the following:

.1 Fire dampers.

.2 Smoke dampers.

.3 Fire stop flaps.

.4 Operators.

.5 Fusible links.

.6 Design details of break-away joints.

.3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for fire and smoke dampers for incorporation into manual.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

.1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.2 Provide:

.1 6 fusible links of each type.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and recycling.

Part 2 Products

2.1 FIRE DAMPERS

.1 Fire dampers: arrangement Type B, bear label of ULC, meet requirements of authorities having jurisdiction and NFPA 90A. Fire damper assemblies fire tested in accordance with CAN/ULC-S112.

.2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.

.1 Fire dampers: 1-1/2 hour fire rated unless otherwise indicated.

.2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.

.3 Top hinged: offset, round or square; multi-blade hinged sized to maintain full duct cross section as indicated.

.4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.

.5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.

.6 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.

.7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.

.8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.

.9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition of floor slab depth or thickness.

.10 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

2.2 SMOKE DAMPERS

.1 Smoke Dampers: to be ULC or UL listed and labelled.

.2 Normally closed reverse action smoke vent (S/D-RASV): folding blade type, opening by gravity upon detection of smoke, and/or from remote alarm signalling device actuated by an electro thermal link. Two flexible stainless steel blade edge seals to provide required constant sealing pressure.

.3 Normally open smoke/seal (S/D-SSSD): folding blade type, closing when actuated by means of electro thermal link and/or from remote alarm signalling device. Blade edge seals of flexible stainless steel to provide required constant sealing pressure. Provide stainless steel negator springs with locking devices to ensure positive closure for units mounted horizontally in vertical ducts.

.4 Motorized (S/D-M): folding blade type, normally open with power on. When power is interrupted damper shall close automatically. Both damper and damper operator shall be ULC listed and labelled.

.5 Electro thermal link (S/D-ETL): dual responsive fusible link which melts when subjected to local heat of 74 degrees C and from external electrical impulse of low power and short duration; ULC or UL listed and labelled.

2.3 COMBINATION FIRE AND SMOKE DAMPERS

.1 Damper: similar to smoke dampers specified above.

.2 Combined actuator: electrical control system actuated from smoke sensor or smoke detection system and from fusible link.

2.4 FIRE STOP FLAPS

.1 Fire smoke flaps: ULC listed and labelled and fire tested in accordance with CAN/ULC-S112.2.

.2 Construct of minimum 1.5 mm thick sheet steel with 1.6 mm thick non-asbestos ULC listed insulation and corrosion-resistant pins and hinges.

.3 Flaps held open with fusible link conforming to ULC-S505 and close at 74 degrees C or as indicated.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for fire and smoke damper installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

.1 Install in accordance with NFPA 90A and in accordance with conditions of ULC listing.

.2 Maintain integrity of fire separation.

.3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.

.4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.

.5 Co-ordinate with installer of fire stopping.

.6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.

.7 Install break-away joints of approved design on each side of fire separation.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: separate waste materials for recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 General

1.1 SUMMARY

.1 Section includes:

.1 Design, performance, controls, and installation requirements for custom air handling units.

1.2 REFERENCES

.1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA)

.1 ANSI/NFPA-90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 Canadian General Standards Board (CGSB)

.1 CGSB 1-GP-181M, Ready-Mixed Organic Zinc-Rich Coating.

.3 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)

.4 AMCA Standard 99

.5 AMCA Standard 210

.6 AMCA Standard 500

.7 ASHRAE/ANSI Standard 111

.8 ASHRAE Standard 52

.9 ANSI/ASHRAE 15

.10 UL Standard 1995

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawing and product data in accordance with Section 01 33 00 - Submittal Procedures.

.2 Indicate the following:

.1 Fan curves showing point of operation with motor characteristics, filters, heating/cooling coil performance and physical data, pressure drop over each section, unit drawings and dimensions.

PART 2 Products

2.1 GENERAL

.1 Horizontal type, as indicated, having air tight modular components or knockdown, consisting of casing, mixing box with return or intake section, and outdoor air dampers, filter sections, cooling coil, humidifier, heating coil, fan section with motor and drive.

.2 Note: access to the penthouse is limited by door sizes, elevators sizes, existing equipment and services, etc. Contractor to examine site and ensure equipment supplied can be installed in existing location.

.1 Installation of the units and additional cost for installation will be the sole responsibility of the contractor.

.3 Seal all gaps, holes, joints, for no air leakage.

.4 Acceptable material: Carrier, York, McQuay

2.2 CASING

.1 Unit casting shall be minimum 18 gauge steel with a galvanized or satin coated steel panels and seams broken inward for clean flush appearance.

.2 All segments and panels shall be double walled with 50 mm (2") non-compressible fiberglass insulation throughout. All panels shall be completely gasketted prior to shipment with a minimum of 6.4 mm (1/4") thick and 19 mm (3/4") wide closed cell neoprene.

.3 Walk in access doors shall have similar construction with welded seams for rigid construction. A tempered or wire glass window shall be provided for each door. Door openings shall be fully gasketted with continuous closed cell hollow round black gasket with metal encapsulated reinforced backing mechanically fastened to door frame. Two latches operable from both sides required.

.4 The cooling coil segment shall have a stainless steel multi-sloped drain pan, extended full width of the coil and far enough down stream to capture moisture carry over. Units with coil heights in excess of 1220 mm (48") shall have intermediate drain pan with drop tubes to guide moisture to main drain pan. Provide plastic drain to exterior of unit.

.5 Unit shall have continuous base rail with integral lifting lugs. The base rail shall be constructed from 12 gauge steel channel. Minimum height of base rail as per manufacturers recommendations.

.6 Coil end sheets shall have deep drawn tube holes to permit tube movement free of stress.

2.3 FAN SECTION

.1 General: Plenum fan assemblies shall be arrangement one or four. Arrangement three plenum fans are not acceptable because they are less efficient and generate more noise. The air handling unit manufacturer, for the purpose of sole source responsibility, shall

manufacture all fan assemblies. Fan wheels supplied shall be in accordance with AMCA standard 210.

.2 Fan performance shall be based on tests run in an AMCA certified laboratory and administered in accordance with AMCA Standard 210. Fan performance tests shall be taken with fans running inside the cabinet to include any affects from the unit cabinet and other internal components. Fans shall bear AMCA seal for air and sound.

.3 Plenum fans shall be configured

.1 Both fan bearings are on the drive side of the over hung fan wheel OR

.2 Direct-coupled to the motor

.4 There shall be no obstructions (i.e., bearings or bearing supports, etc.,) at the inlet of the fan. Fan wheel shall be aluminum with aluminum extruded airfoil blades. Fan bearings shall have a minimum L-200,000 Hr. operating life and be mounted on a structural steel channel or machined surface. Plenum fans shall be provided with spring or rubber-style thrust restraints.

.5 DWDI fans the structure supporting the bearing shall be fabricated from structural steel and be detachable to allow for removal of the fan wheel and shaft as one piece. The fan discharge shall be isolated from the cabinet by means of a neoprene-coated flexible connection.

.6 Each fan shall be sized to perform as indicated on the equipment schedule. The wheel diameter shall not be less than that shown on the equipment schedule. The fan shall be constructed to AMCA Standards for the Class Rating as indicated on the Equipment Schedule

.7 Provide grease fittings and extend lubrication lines to the motor side of the fan, just inside the access door

.8 Removable OSHA qualified belt guards shall be provided for non-direct drive fans.

.9 Provide OSHA inlet screens on fans.

.10 Fan Base, Spring Isolation, and Support Framing: Mount fan and motor on an internal, fully welded, rigid structural steel base. Base shall be free-floating at all four corners on spring type isolators with seismic earthquake restraints. The fan assembly shall be isolated from the cabinet by steel springs with minimum deflection of 2.0" or as indicated on the schedule. The spring isolators shall be mounted to structural steel members. All isolators shall be rated for zone 4 seismic requirements. The spring isolators shall be mounted on a waffle pad for vibration isolation.

.11 Motors and Drives: Furnish premium-efficiency ODP NEMA frame, ball bearing type motors, with grease lubricated bearings and alemite fittings. Horsepower's as shown on the schedule are minimum allowable.

.12 The motor shall be mounted on an adjustable slide rail motor base. The fan motors shall be factory wired to an external junction box with flexible conduit of adequate length so that it will not have any effect on the vibration isolation.

.13 Provide synchronous type belts, cast-iron sheaves, and reinforced rubber belts. The belts shall be selected for 150% of the motor nameplate horsepower. Drives shall be "Browning" or equal.

.14 Balancing: The fan shaft shall be sized not to exceed 75% of the first critical speed for the maximum RPM of the fan Class specified. The critical speed will refer to the top of the speed range of the fans' AMCA class. The lateral static deflection shall not exceed 0.003" per foot of the length of the shaft. Fans shall be balanced to ISO standard G6.3.

.15 A copy of the above balance test data for this project showing calculations for deflection and critical speed of the shaft and wheel assembly shall be submitted to the engineer and a copy forwarded to the Owner.

2.4 COILS

.1 All cooling and heating coils shall be furnished to meet the performance set forth in schedules. All coils shall have performance certified in accordance with ARI Standard 410.

.2 All coils shall be installed on slide out racks to facilitate coil removal and maintenance. Provide sectioned covers on coil ends to facilitate inspection.

.3 Hydronic coils shall be design to operate at 1.720 MPa (250 psi) gauge pressure at 149 C (300 F) and shall be tested using compressed air at 2.240 MPa (325 psi) gauge pressure. Coils shall be design for counter flow of working fluid and air. The coil shall have cleanable fins, copper tubes, aluminum plate fins, seamless copper tube headers.

.4 Direct expansion coils shall conform to ANSI B9.1 when operating a refrigerant pressure not exceeding 1.720 MPa (250 psi) gauge pressure and shall be tested using compressed air at 2.240 MPa (325 psi) gauge pressure. The coil shall have cleanable fins, copper tubes, aluminum plate fins, seamless copper tube headers.

.5 Cooling coil shall be provided with continuous blow down for freeze protection.

2.5 FILTER SECTION

.1 Filter sections shall be fabricated as part of the air-handling unit. Filters shall be arranged for upstream, downstream, or side loading as shown on the drawings. Provide filter-holding frames to accommodate scheduled filters. Filter frames shall be 16 Ga. Galvanized steel and shall be welded to reduce leakage of air through corners.

.2 Factory install at each filter bank a Magnehelic pressure gauge complete with static pressure tips, hardware and fittings. Enclose the gauge in a 304 stainless steel protective weatherproof box with a hinged inspection door.

.3 Refer to drawings for configuration.

2.6 MIXING BOX

.1 Mixing box shall be design to provide uniform temperature, plus or minus 5 C.

.2 The mixing box section shall consist of multi-leaf, parallel acting blades, with inter-connecting return air and outside air damper. The motorized dampers shall be located as indicated in drawings and shall be ultra-low leakage with aerofoil blades constructed of 14 gauge, double skin, galvanized steel. The damper blades shall be gasketted with extruded vinyl edge seals.

2.7 DAMPERS AND LOUVRES

.1 Dampers and Louvers: Dampers shall be supplied with low leak extruded aluminum airfoil blades. Blades shall be supplied with rubber edge seals and stainless steel arc end seals. Rubber edge seals shall be backed by the damper blade to assure a positive seal in the closed position. Dampers shall be provided with nylon bearings within extruded openings. Damper leakage shall not exceed 6 cfm/ft2 at 5.0" of static pressure. Leakage testing shall be in accordance with AMCA standard 500 figure 5.5. Test results must be from independent testing laboratory. Provide louvers for outside air and exhaust air for units located outdoors. OSA Louvers shall be sized for a maximum face velocity of 500 fpm based on gross louver face area. Louvers shall have zero water penetration at 600-ft/min air velocities.

.2 Maximum louver pressure drop shall be 0.03" in w. g. at 500 ft/min. Provide test results from independent testing laboratory. Test must be conducted in accordance to AMCA Standard 500 figure 5.5. Louver water carry over must be less than 0.01 oz/ft2 at 1100 ft/min of free louver face area. Test must be conducted by independent testing laboratory per AMCA 500-89 figure 5.6. Hoods may be used instead of louvers where necessary.

2.8 AIR FLOW MEASURING AND CONTROL

.1 Fans shall be supplied with a complete flow measuring system capable of supplying a 4 - 20mA. output signal to the EMS system that is proportional to airflow. The flow measuring station and a flow transmitter shall be factory mounted. The flow measuring station shall consist of pressure taps located in the inlet cone of each fan. Provide a gauge with CFM scale on external side of the fan sections, which indicates the fan volume.

.2 The electronic flow transmitter shall be mounted on the exterior of the fan section. It shall be capable of receiving signals of total and static pressure from a flow element, of amplifying, extracting the square root, and scaling to produce a 4 - 20 mA or 0 - 5 VDC output signal linear and scaled to air volume or velocity. The flow transmitter shall be capable of the following performance and application criteria.

.3 Calibrated spans from 0 - 896 FPM, in eight flow range increments. Output signal 4 -20 mA or 0-5 VDC standard. Integral zeroing means 3-way zeroing valve with manual switch. Temperature effect ± 2.0% of full span from 40° to 120°F.

.4 The transmitter shall not be damaged by over-pressurization up to 200 times greater than span, and shall be furnished with a factory calibrated span and integral zeroing means. The transmitter shall be housed in a NEMA 12 enclosure with external signal tubing, power, and output signal connections.

2.9 VARIABLE FREQUENCY DRIVES:

.1 Drive manufacturer shall provide, coordinate and start-up a variable speed drive system to ensure proper application of equipment to the driven load. Factory warranty for a period of one year from date of start-up shall apply for both motor and drive.

.2 VFD shall be current rated at 8 kHz carrier frequencies for VFD's 1-75 HP and 4 kHz for VFD's 100-400 HP. All HP ratings shall meet or exceed Table 430-150 of the National Electric Code. Three phase motor full load currents, HP, maximum current, and rated voltage shall appear on the drive nameplate. No derating of the VFD shall be required due to increasing the switching frequency for motor noise reduction. All drives designed at greater than 8 kHz carrier frequency (regardless of kHz rating level of VFD) shall include an output voltage rise time reduction device as part of the VFD.

.3 VFD and options shall be ULTM 508 listed.

.4 NEMA 12 enclosed VFD shall be ULTM approved for mounting in conditioned air ducts and plenums.

.5 The drive and options shall comply with the applicable requirement of the latest standards of ANSI, NEMA, National Electric Code NEC, NEPU-70, IEEE 519-1992, FCC Part 15 Subpart J, and CE96.

.6 Each drive shall be subjected to the following test and quality control procedures. Every VFD shall be functionally tested under motor load. During this load test the VFD shall be monitored for correct phase current, phase voltages, and motor speed. Correct current limit operation shall be verified by simulating a motor overload.

.7 Verification of proper factory presets by scrolling through all parameters shall be performed to ensure proper microprocessor settings. The computer port should also verify that the proper factory settings are loaded correctly in the drive.

.8 All options shall be functionally tested including operation of a motor in the bypass mode if supplied. Proper heater coil installation in motor overload, if supplied, shall be verified.

.9 The VFD shall have the following basic features:

.1 An electronic overload circuit designed to protect an A-C motor operated by the VFD output from extended overload operation on an inverse time basis. This electronic overload shall be ULTM and NEC recognized as adequate motor protection. No additional hardware such as motor overload relays or motor thermostats shall be required.

.2 An LED display mounted on the door of the cabinet that digitally indicates:

.3 Frequency output

.4 Voltage output

.5 Current output

.6 Motor RPM

.7 Input kW

.8 Elapsed time

.9 Time stamped fault indication

.10 DC Bus volts

.10 The VFD shall have the capability of riding through power dips up to 10 seconds without a controller trip depending on load and operating condition. In this extended ride through, the drive shall use the energy generated by the rotating fan as a power source for all electronic circuits.

.11 RS232 Port and Windows TM based software for configuration, control and monitoring.

.12 An isolated 0-20mA, 4-20mA or 0-4, 0-8, 0-10, volt analog speed input follower.

.13 An isolated 0-10 volt or 4-20mA output signal proportional to speed or load.

.14 The VFD shall include the following protective circuits and features:

.1 Motor current exceeds 200% of drive continuous current rating.

.2 Output phase-to-phase short circuit condition.

.3 Total ground fault under any operating condition.

.4 High input line voltage.

.5 Low input line voltage

.6 Loss of input or output phase.

.15 External fault (this protective circuit shall permit wiring of remote N.C. safety contact to shutdown the drive). User supplied end switches, thermal switches; fire stats, freeze stats inputs will be connected to this VFD supplied circuit.

.16 Metal oxide varistors for surge suppression shall be provided at the VFD input terminals.

.17 Complete contactor bypass shall be provided to allow motor to be safely transferred from VFD output to the A-C line, or from the A-C line to the VFD, while the motor is at zero speed. The contactor bypass shall utilize two motor contactors electrically interlocked. One contactor is to open and close the connection between the VFD output and the motor. The other contactor will open and close the connection between the bypass power line and the motor, providing "across the line" starting. Motor protection is to be provided in the "bypass" mode by a bi-metallic Class 20 Smart Motor Protection adjustable overload relay. Relay control logic shall also be included within the VFD enclosure to allow the same "Start/Stop" command to operate the motor in either mode. The relay logic shall be 115 volts. The bypass circuit shall include a second disconnect installed in the VFD to provide the ability to safely troubleshoot and test the controller, both energized and de-energized, while the motor is running in the "bypass" mode. A contact closure shall be provided to indicate that the drive is in the "bypass" mode. A remove/local selector switch shall also be provided to transfer control from the keypad to user wired signals. Form "C" normally open and normally closed contacts shall be provided for both run and IET/drive stopped. The entire bypass option shall be packaged with the controller enclosure and be mechanically isolated from the VFD.

.18 Input line fuses shall provide protection for the input rectification circuit using Class J fuses with interrupting rating of 200,000 AIC. The series interrupting rating of the VFD and fuses shall be a minimum of 30,000 AIC and shall be stated in the VFD instruction manual as required by UL.

.19 A main input disconnect shall mount within the standard NEMA 1 or NEMA 12 enclosure for positive power disconnect of the VFD. It shall have the capability for door padlocking.

.20 A three phase 3% impedance input line reactor shall be provided to minimize drive harmonics on an A-C line and protect the drive from damaging electrical system transients.

.21 Ensure all disconnects are knife style, to match existing facility disconnects.

2.10 UNIT MOUNTED CONTROLS

.1 The unit shall be controlled by a DDC control system, and interfaced with the existing building controls system.

2.11 HUMIDIFIER SECTION

.1 Where indicated on drawings, provide humidification section.

.2 Provide section with adequate spacing for short absorption manifold distributor if ductwork can not accommodate distributor.

.3 Section shall have full width stainless steel drip pan, sloped to drain.

.4 Access door: waterproof walk in.

2.12 UNIT MOUNTING

.1 Unit shall be assembled on structural channels suitable for hanging the unit from the roof structure with rods or suitable for supporting from the floor.

.2 Provide rubber-in-shear vibration isolators between the unit and the supporting channels for vibration control.

2.13 SCHEDULE

.1 Scheduled characteristics govern where they conflict with the general descriptions herein.

PART 3 Execution

3.1 GENERAL

.1 Ensure adequate access space on all sides of the air handling units, including coil removal.

.2 Ensure vibration free mounting of all units.

.3 Mount unit on 100 mm concrete pad.

.4 Change and adjust motor sheaves as required to suit the Air Balancer.

.5 Connect all drains and run to nearest building drain. Install deep seal traps a minimum of 50 mm (2") deeper than static pressure at each connection point.

.6 Demonstrate water tightness of drain pans, upon request.

END OF SECTION